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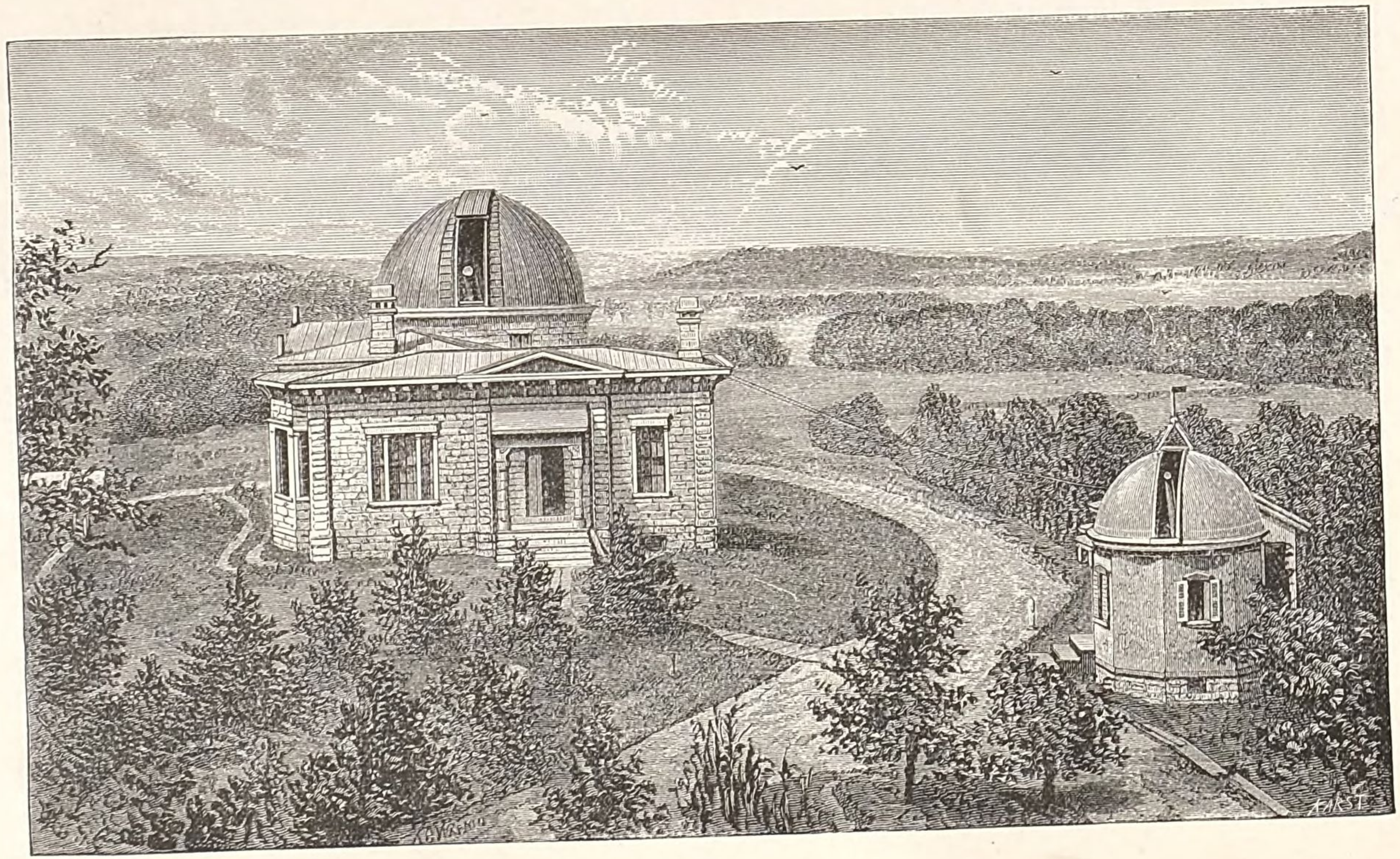

PUBLICATIONS

OF THE

WASHBURN OBSERVATORY

OF THE

UNIVERSITY OF WISCONSIN.

VOL. II.

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WASHBURN OBSERVATORY.

FOUNDED BY

CADWALLADER C. WASHBURN,

BORN 1818; DIED 1882.

EDWARD S. HOLDEN, - - - - - DIRECTOR.*
JOHN TATLOCK, JR., - - - - ASSISTANT ASTRONOMER.†
GEORGE W. BROWN, (Student) - - METEOROLOGICAL OBSERVER.‡
JOHN DOESCHER, - - - - - - JANITOR.

BIBLIOTHECA
REGIA
MONACENSIS

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*Absent in charge of the U. S. Solar Eclipse Expedition to the South Pacific Ocean March—July 1883, during which time Mr. GEORGE CARY COMSTOCK was in charge of the Observatory, with Mr. G. E. BROWN as assistant.

†From July 1, 1883, to August 1, 1884. ‡Since December 12, 1883.

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WASHBURN OBSERVATORY.

I. ADDITIONS TO THE BUILDINGS AND INSTRUMENTS.

At the date of the printing of Volume I. of the *Publications of the Washburn Observatory*, the buildings were practically completed, as shown in the frontispiece of the present volume.

Some slight changes have been made however, and the most important of these will be briefly mentioned. A few instruments and minor pieces of apparatus have also been bought.

WEST ROOM (*Meridian-Circle.*)

The interior of this room has been completely remodeled in order to fit it to receive the REPSOLD Meridian Circle, mounted at the close of 1882. The room is only 22 feet 4 inches (E. and W.) by 20 (N. and S.) This is really too small, but by economizing our space it has been made satisfactory. The piers and the principal fittings for the Circle proper will be spoken of in the *Description of the Meridian Circle.* Here it may be said that the shutters have been changed so as to work fairly well; and especially that the ventilation of the room has been improved so as to insure an equality between the exterior and interior temperatures. How this has been effected is related in the *Description* above cited.

A double-shelter for the Meteorological Instruments has been placed at the north-east window. The two south windows have been painted with a thin coat of white paint. This allows light to pass and prevents the Sun's heat from affecting the Circle. A small stove has been mounted in the room permanently. It is lighted whenever the instrument begins to drip with dew, as is not uncommon in the spring and fall.

LARGE DOME.

This continues to be satisfactory in all respects, except that the upper shutter should be replaced by one of light steel.

EAST ROOM (*Clock-Room.*)

No changes have been made in the room itself. The pier on the north side of the room has been used for the HOWARD Mean Time Clock (No. 221), since 1882, July 7th. The THOMAS Clock has been moved into the Hall, near the switch-board. A oil-painting of Governor WASHBURN, and a life size crayon drawing of Professor WATSON have been placed in this room.

THE SOLAR AND STUDENTS' OBSERVATORIES.

The Solar observatory has been used solely as the quarters for an assistant after the conclusion of the experiments described in *V. J. S. der Ast. Gesell,* 1883, page 114. The Students' observatory has been lighted with gas since November 1882.

THE PIVOTS OF THE FAUTH TRANSIT INSTRUMENT.

The inequality of the pivots of the Fauth Transit has been investigated by Miss ALICE SANBORN, student in Astronomy. The results are as follows:

INDIVIDUAL VALUES OF P.

First Series.—Telescope Pointing South.—1882.

Date.	*p.*	*Date.*	*p.*	*Date.*	*p*
	d		d		d
Oct. 25,	+ 0.10	Nov. 1,	— 0.30	Nov. 8,	— 0.25
Oct. 25,	— 0.30	Nov. 1,	— 0.36	Nov. 8,	— 0.34
Oct. 25,	— 0.33	Nov. 2,	— 0.40	Nov. 8,	— 0.27
Oct. 25,	— 0.56	Nov. 2,	— 0.42	Nov. 8,	— 0.19
Oct. 31,	— 0.30	Nov. 2,	— 0.12	Nov. 9,	— 0.39
Oct. 31,	— 0.37	Nov. 3,	— 0.27	Nov. 9,	— 0.56
Oct. 31,	— 0.49	Nov. 3,	— 0.31	Nov. 9,	— 0.05
Oct. 31,	— 0.56	Nov. 3,	— 0.22	Nov. 9,	— 0.38
Oct. 31,	— 0.34	Nov. 3,	— 0.20	Nov. 10,	— 0.38
Nov. 1,	— 0.31	Nov. 6,	— 0.22	Nov. 10,	— 0.25
Nov. 1,	— 0.41	Nov. 6,	— 0.11	Nov. 10,	— 0.35
Nov. 1,	— 0.33	Nov. 6,	— 0.25	Nov. 10,	— 0.30
Nov. 1,	— 0.24	Nov. 6,	— 0.10		

Mean value of p $= -\overset{d}{0}.3008 \pm \overset{d}{0}.0133$.

Probable error of one determination, $\pm \overset{d}{0}.0820$

$p = -\overset{s}{0}.0322 \pm \overset{s}{0}.0014$.

Second Series. Telescope pointing North.—1882-3.

Date.	p_d	*Date.*	p_d	*Date.*	p_d
Nov. 13,	— 0.11	Nov. 20,	— 0.20	June 12,	— 0.16
Nov. 13,	— 0.20	Nov. 20,	— 0.31	June 12,	— 0.34
Nov. 14,	— 0.34	Nov. 21,	— 0.15	June 12,	— 0.34
Nov. 14,	— 0.35	Nov. 21,	— 0.17	June 12,	— 0.18
Nov. 14,	— 0.24	Nov. 21,	— 0.27	June 12,	— 0.35
Nov. 14,	— 0.14	Nov. 21,	— 0.07	June 12,	— 0.35
Nov. 20,	— 0.16	Nov. 21,	— 0.19	June 12,	— 0.28
Nov. 20,	— 0.36	Nov. 21,	— 0.21	June 12,	— 0.37
Nov. 20,	— 0.17				

Mean value of p $= -\overset{d}{0}.2404 \pm \overset{d}{0}.0140$.

Probable error of one determination, $\pm\overset{d}{0}.0701$.

p $= -\overset{s}{0}.0257 \pm \overset{s}{0}.0015$.

Combining the result from both series we find p $= -\overset{s}{0}.029 \pm \overset{s}{0}.001$.

The linear difference in the radii of the pivots is 0.000053 inch, the clamp pivot being the larger.

THE SIDEREAL CLOCK.

The Sidereal Clock has had its correction determined once every three days (on the average) since it was mounted. A daily comparison is made between this clock and all the other time-pieces in the Observatory; and the Tower Clock is also daily compared with the standard mean-time clock, through the telephone. A complete record of the running of each time-piece is kept.

The barometer and a thermom eter screwed to the wooden back of the sidereal clock case (inside the case) have also been read daily since August 1881.

During the period August 1883 to January 1884 the readings of a maximum and a minimum thermometer which are fastened inside the wall of the (outer) clock closet surrounding the sidereal clock have also been taken, as well as the reading of the clock thermometer at about 11 p. m.

Supposing the mean of the maximum and minimum thermometers to indicate the mean daily temperature of the air in the clock closet, the following points have been established. The temperature inside the clock case proper follows the temperature of the clock closet closely, being perhaps an hour in retard. The daily range of the tempera-

ture inside the clock-case is about the same as the daily range of temperature in the clock closet. The reading of the clock-thermometer at 7 a. m. is very nearly the mean daily temperature. The mean of the readings of the clock-thermometer at 7 a. m. and 11 p. m. is also very near the mean daily temperature, and there is no special advantage in reading the clock-thermometer more than once daily, *viz.* at 7 a. m. The clock is mounted on the very substantial pier in the following manner. A solid iron hook for the support of the back is set firmly at the top of the pier with plaster of Paris. A wooden batten (ash) is placed horizontally on the front of the pier, and at the same height above the floor is another batten, at the back of the pier. These two are connected by two iron rods with screws cut on their ends and nuts playing on these. Thus the two battens are clamped tightly against the faces of the pier. The bottom of the clock-case is clamped against the front batten by two large screws. The principle of this mounting is that the whole weight of the clock is suspended from the iron hook and that the back of the clock case is kept in one position by the screws which clamp it against the bottom batten. In spite of all precautions, I have found that the back of the clock case will warp from time to time and that it changes its shape from winter to summer. This warping destroys the effect of the accurate adjustment of the beat-screws of the clock, and it tends also to destroy the accurate swinging of the pendulum in one plane. Unless the pendulum swings in one plane the rate cannot be constant.

I therefore think that for the best performance of this clock, it would be proper to fasten the wooden back of the clock case firmly against an iron back, and to bolt this iron back firmly to the pier. The iron back of the HOWARD mean time clock is an excellent feature of its mounting.

I have not been able to allow the sidereal clock to run without stopping for the period of 1881 April to 1883 December, as I had hoped, but I have had to stop it on several occasions, in order to adjust the swinging of the pendulum to one plane.

The periods which are available for discussion of the running of this clock are:

1881. August — December.
1882. January — December.
1883. January — June.
1883. June — December.

If R_o be the rate of the clock at barometer = 30 inches and thermometer = 40°, and R be the rate of the clock at a given barometer (B) and the temperature (t), the formula which best represents the running of the clock is

$$R = R_o + 0^s.30\ (B - 30) - 0^s.034\ (t - 40^o).$$

It is obvious that the temperature coefficient is enormously too large, and I shall alter the quantity of mercury in the jar, until a better compensation is secured, beginning these changes with the year 1884. I have compared the rate computed from the above formula with the observed rate for 100 different cases, from January 1882, to December 1883, and I find that the sum of 100 residuals taken without regard to sign is $14^s.28$ or the average residual is $0^s.14$.

On 1884 January 12, I took out 54.50 grams of mercury, and placed two brass weights centrally on top of the pendulum bob.

On January 19th, the rate of the clock at barometer 30 inches and $t = 65.5^o$ was $+0^s.686$, and at barometer 30 inches and $t = 36.8$ it was $+0^s.402$. That is the formula given above was changed to $R = R_o + 0^s.30\ (B - 30) + 0^s.010\ (t - 40^o.)$

On January 21st, I replaced 13.8 grams of mercury, and in this condition, the clock will be allowed to run during 1884.

It must not be forgotten that the two circular pieces of brass which have been added are now to be considered as an integral part of the pendulum.

It should be mentioned that the maker of the clock has added to the pendulum bob (at the bottom) a small glass mirror. If a beam of sunlight be thrown upon this mirror a spot of light is reflected by it upon the west wall of the clock-room. Here I have placed a plumb-line, along which the spot travels, as the pendulum swings. This observation is made once or twice per month. The arc through which

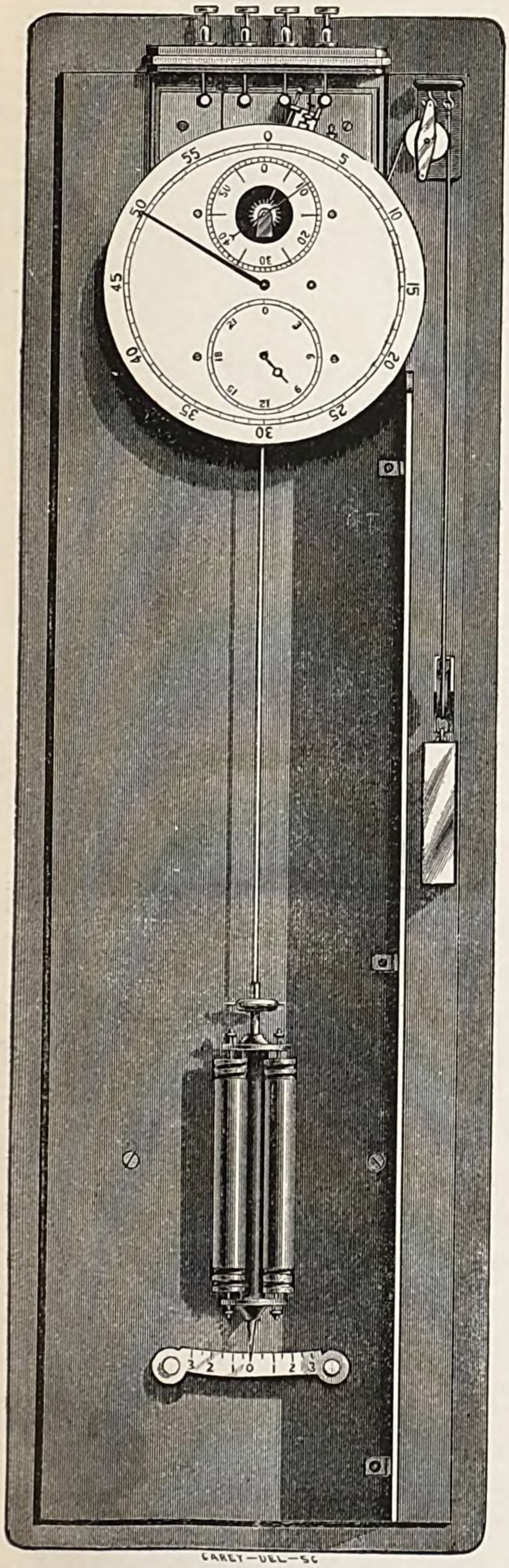
the pendulum swings is observed daily. It appears to decrease from 1°29′ to 1°25′ for a fall of temperature of 10°; and it also appears to decrease as the driving weight falls. I have increased the driving weight slightly, and it is possible that further experiments may determine that the clock should be wound daily.

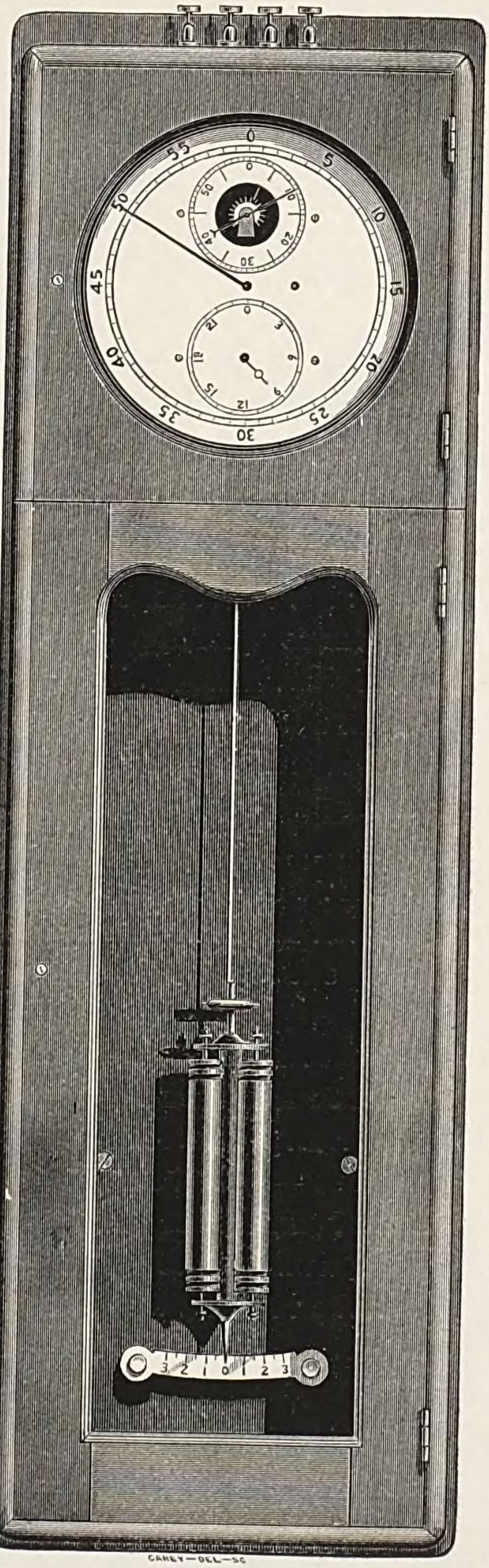
THE HOWARD CLOCK.

This clock is regulated to mean-time. Up to November 23 1883, its face showed Chicago mean-time. (Chicago 7^m 11^s. 11 east of Madison.) After that date it showed "Central time," *i. e.* the local time of the meridian 90° west from Greenwich. (Central time is 2^m 22^s. 11 slower than Madison time.) It is used as the standard mean-time clock, and especially to send a time-signal at 10 a. m. daily (except Sunday), to railways in Wisconsin, and to send signals every 2^s during the day-time to various places in the city of Madison.

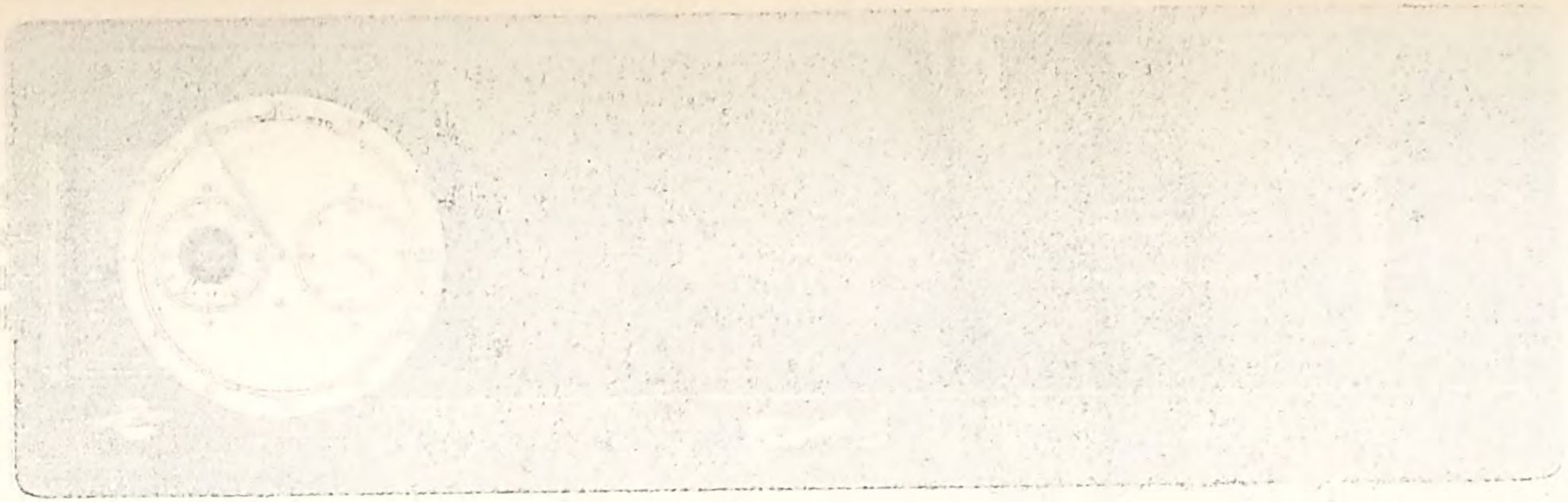
The *escapement* is GRAHAM'S. The *pendulum* is a steel rod which carries four steel jars in a cluster, each jar being filled with mercury. The seconds-arbor has a steel scape wheel of thirty teeth (one being cut away). This wheel touches a spring every 2^s and sends a signal through a relay. The 58th second is omitted in every minute. A wheel on the 5-minute arbor has a notch 10^s long cut into its rim. Into this notch a detent falls once in 5 minutes, and the signals are interrupted every 5 minutes from 50^s to $60.^s$ The clock thus sends break-circuit signals (to its own "back-contact" relay at the switch-board) every 2^s with the exception of the 58th second in *every* minute and the 52d, 54th, 56th and 58th, in every 5th minute. From the relay either *break* or *make* signals can be sent. On the pendulum rod just above the bob, is a screw thread, on which a little nut can be moved up and down about 3 inches of the length of the rod. This nut is made in the shape of a pilot-wheel with 8 spokes, one of which has been painted black. One turn of the nut is $0^s.18$ per day in the rate, and one-eighth of a turn is $0^s.001$ per hour. This clock is compared twice daily with the sidereal clock, at 8 a. m. and about 11 p. m.

The nut is so placed as to bring the correction of the clock





THE HOWARD MEAN TIME CLOCK.



to as nearly zero as possible at 10 a. m. of the succeeding day. The average error of our railway time signals at 10 a. m., was:

For September, 1883, 0.^{s}08
For October, 1883, 0.07
For November, 1883, 0.11
For December, 1883, 0.06

The whole clock is mounted on an iron back, which is firmly screwed by 4 bolts (set into lead) to the stone pier.

The constant changes which are made in the rate of the clock have prevented me from forming any accurate idea of its performance. For its special purpose I regard its arrangements as well nigh perfect. Clocks of this maker should be always used so as to *open* a closed circuit, not to *close* an open one, as the adjustment of the 2^s signal apparatus can be made much lighter.

THE CONTROLLED CLOCKS.

The observatory controls seven clocks in the city of Madison. The single wire (No. 2) goes from the ground at the observatory to the tracks of the Chicago, Milwaukee & St. Paul Railway, and along these to the city, passing through clocks at the offices of S. L. SHELDON, the Western Union Telegraph Co., the State Bank, the Wisconsin State Journal, the first National Bank, the Supreme Court of Wisconsin, and of the Park Hotel. Here it goes to ground. Clocks along this line have their hands set hourly from the observatory. (DUDLEY system).

A special line is also run to the office of the President of the University, and a clock is set daily in this room. This clock automatically rings an electric bell in each class room at each hour, and ten minutes before each hour.

THE LIBRARY.

The Library has received a gift of money from Hon. CYRUS WOODMAN of Cambridge, for the purchase of new books. It is now a very excellent working library of astronomy of about 1000 volumes and 600 pamphlets. In particular, its collections of recent star catalogues is very complete, and what is better, each catalogue has been corrected for every

known error up to now. The Washburn Observatory holds itself ready to correct the catalogues of other observatories on terms which are detailed in *Science* for 1883 August 24. Mr. WOODMAN has also given a permanent fund, half of the income of which is to be applied to the uses of the library, the other half going to increase the principal. The library is to be called the WOODMAN ASTRONOMICAL LIBRARY OF THE WASHBURN OBSERVATORY.

I desire to renew my thanks to the many scientific societies, observatories and astronomers who have generously presented the library with their publications; and to the Smithsonian Institution which forwards these to us free of expense.

THE SIX-INCH CLARK EQUATORIAL.

The six-inch equatorial made by ALVAN CLARK & SONS in 1870, for Mr. S. W. BURNHAM, and temporarily mounted in the dome of the Students' Observatory in 1881, was bought by the Regents of the University in January, 1882, for $1200.

It has an aperture of six English inches, and the distance from the center of the objective to the webs of the micrometer is 93.75 inches. It is driven by an excellent clock.

There are four negative eyepieces, with which Mr. BURNHAM discovered some 400 of his double stars. They are:

L	field	= 30′;	power	= 57	Made by CLARK.
M		= 15′;		= 133	
N		= 7.5;		= 250	
O		= ?;		= 460	

Also a solar eyepiece, and a diagonal tube by CLARK. A poor micrometer by BROWNING has four eyepieces, w, x, y, z, of powers 125, 176, 300, 380. I have had an adapter made, so that the six-inch telescope will now carry any of the eyepieces of the large equatorial—even its micrometer.

AURORA–SPECTROSCOPE.

The Trustees of the BACHE-fund of the National Academy of Sciences (Professor J. D. DANA, Dr. WOLCOTT GIBBS, Professor J. E. HILGARD) granted $300 from the income of the fund for the purpose of constructing a spectroscope especially for the purpose of observing the spectrum of the Aurora and

of the Zodiacal Light. This spectroscope is now making, from designs by Dr. C. S. HASTINGS.

The aperture of the telescope and collimator are 2.67 inches (triple objectives by STEINHEIL), their focal length is 13.4 inches. The eyepiece magnifies 17 diameters. The prism is of bisulphide of carbon and the apparatus gives a spectrum of 3° from A to H.

It is hoped to receive this instrument (which is the property of the National Academy of Sciences) during 1884, and to begin observations at once.

MINOR INSTRUMENTS AND APPARATUS.

For the use of students there have been bought

A SPENCER & BROWNING *Sextant*,

A mean-time chronometer TOBIAS, No. 4804.

An Astral lantern (BAILEY'S),

A sun-dial.

A *spherometer-caliper*, made by FAUTH & Co., on the plans of Professor HARKNESS, U. S. Navy, has been used in connection with the pivots of the REPSOLD Circle as detailed in the *Description of the Meridian Circle.*

A STEINHEIL wedge ("moderations-glas") has been fitted for solar observations.

METEOROLOGICAL INSTRUMENTS.

The instruments, etc., of the Signal Station of the U. S. Weather Bureau at Madison (abandoned) were turned over to the Observatory, and since August 1883, tri-daily observations (7 a. m., 2 p. m., 9 p. m.) are made according to the regular programme of the Signal Service for its volunteer observers. These are printed in what follows.

II. DESCRIPTION OF THE REPSOLD MERIDIAN CIRCLE.

The Washburn Observatory has lately come into possession of a Meridian Circle by the REPSOLDS of Hamburg. In the course of setting this instrument in place, I have had occasion to examine certain parts of it thoroughly; other parts, as the division of the circle, I hope to examine subsequently in the same way. It has appeared to me that the results of this examination would be of especial interest to Astronomers in America, to whom the work of the REPSOLDS is not so familiar as it is to Europeans. In what follows, I have taken the liberty of expressing my own opinion freely, but not without reflection, as to the merits or demerits of our circle, as they appear to me. It is only in this way that my remarks can be of any value. In a few points it appears to me that improvements might be made; essentially I believe that the instrument is all but perfect. It also seems to me that these minor points should be explicitly mentioned, since they are all easy of correction by the makers.

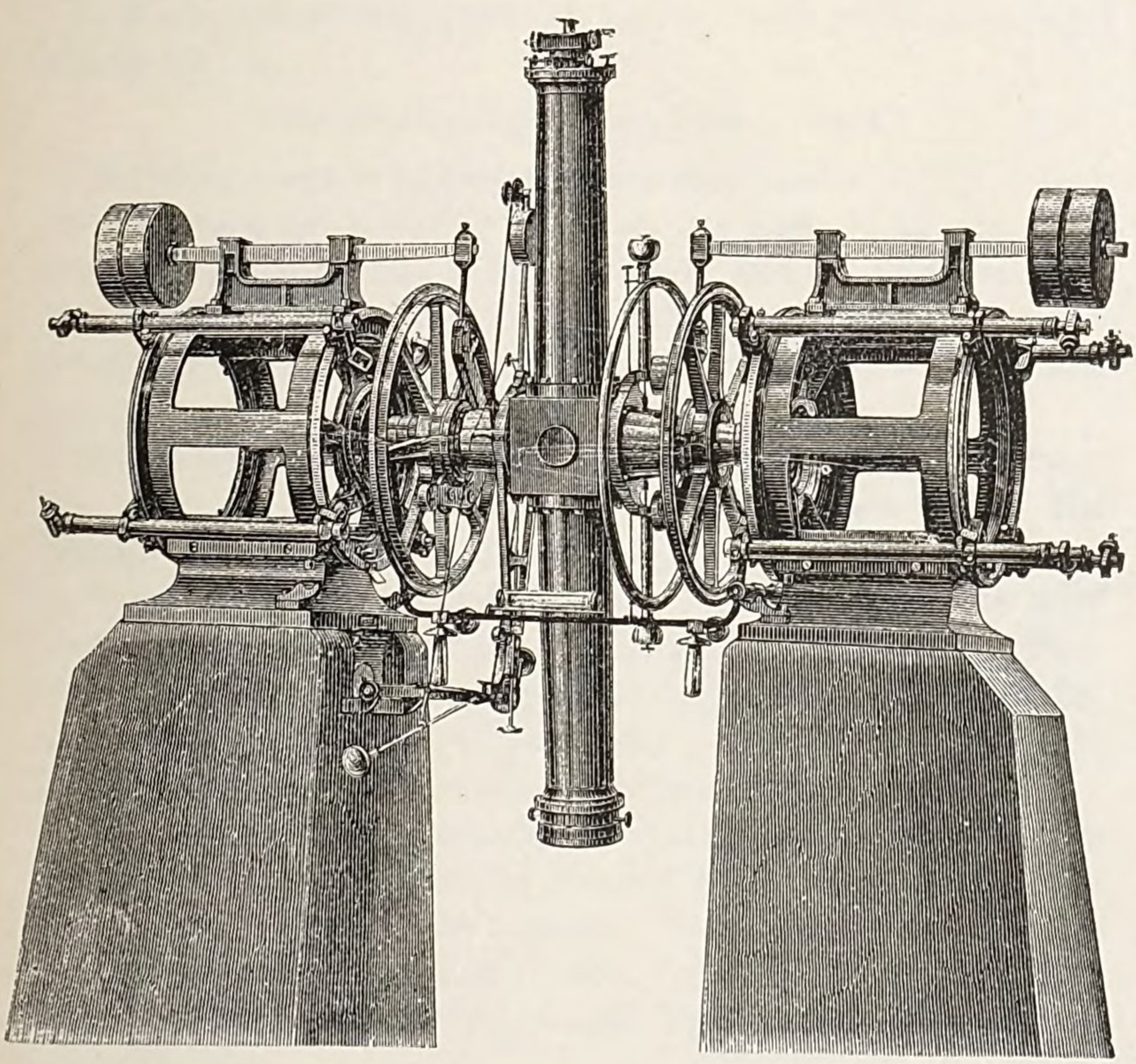
COST OF THE MERIDIAN CIRCLE.

The bill for the circle was as follows:

Meridian circle (proper)	15500		Marks	
Spare level tube (extra)	60		"	
Diagonal eyepiece (extra)	65		"	
Observing chair	400		"	
Boxes and packing	385		"	
Consul's fees (Hamburg)	10	70	"	
Freight to New York	124		"	
Insurance to New York	62		"	
Total cost in New York	16,606	70	"	$4,151 68
The bill of the New York Agents of REPSOLDS was				122 33
This includes express charges, insurance and custom house fees. The total cost of the circle delivered in the Observatory was therefore				$4,274 01

The instrument is mounted in a room which had been prepared by Professor WATSON for the reception of a six inch transit. Extensive changes were made in this room to prepare it for the circle, and the cost of these was somewhere in the neighborhood of $600.

The instrument arrived in perfect order, except a few



"

slight scratches on the divided circle, and not a thing was broken. The spider lines in the reticles were all intact.

The boxes for the circles, the telescope and axis and the collimators were covered with tin, then with straw and finally sewed in bagging. I may mention that, on my application, the Honorable Secretary of the Treasury issued special directions to the officials in the New York Custom House, to handle the cases with care. I believe this precaution was worth taking.

THE WEST ROOM (*Meridian Circle*).

The west room is 22 feet 4 inches (east and west) by 20 feet (north and south), and 13 feet 9 inches high to the flat ceiling. A slit 25 inches wide is closed by two counterpoised shutters on the sloping roof (the ridge line running east and west), and by four vertical shutters, two north and two south.

The ridge-line is 140 inches higher than the flat ceiling; the eaves being 66 inches higher. The space above the ceiling serves as an air space, and the sides of the slit are not ceiled up, as is usual, but they are covered with wire netting on both sides of the slit, so as to allow a free circulation of air. This arrangement is, I believe, first carried out at the Washburn Observatory. Forty-four ventilators in the walls and cornice allow of changing the air.

Prof. WATSON had mounted in this room a 6-inch meridian transit instrument, made by PISTOR & MARTINS in 1856, for the United States Coast Survey. This instrument was his own private property, and it was replaced by the meridian circle ordered from the REPSOLDS, by Governor WASHBURN, early in 1881.

GENERAL DESCRIPTION OF THE MERIDIAN CIRCLE.

The general appearance of the instrument can be seen in the cut herewith.

A photograph of this instrument can be had from the Messrs. REPSOLDS by any one who wishes it. By studying the photograph, or in default of this, the accompanying wood-cut, a better idea of the general construction can be had than by any brief description.

It may be said, however, that all the large iron surfaces are painted an olive green, with the edges bronzed, so as to give a good effect, and so as to protect from rust. The iron or steel screws are all, without exception, nickel-plated, also to avoid rust; and the brass surfaces are lackered. The nickel-plating is a particularly good feature in climates like that of Madison, where for two or three months of the year the air is quite moist, and where instruments are liable to "sweat" badly. It really saves the inconvenience of a glass cover like those at Pulkova and Leyden.

A small point, but a good one, is that the caps for the objectives of the collimators and of the circle, are made of spun-brass, and are therefore light. In general, the only thing to do with the cap furnished by the maker of an instrument, is to throw it away. They are usually so heavy and awkward as to do more harm than good.

Most of the screw heads are fitted to be set up *either* by a screw driver or by a capstan bar. I may mention here that in the one case where it was most important that one should be able to use a screw driver (for two opposing screws which make the transit threads vertical) on account of the small room available between the end of the tube and the micrometer, the screws were made capstan-headed *only*. I have changed these.

As a matter of history, it may be interesting to say that the first capstan-headed screws were made for the CARY circle at Moscow, which is figured in PEARSON'S Practical Astronomy.

THE REVERSING CARRIAGE.

This is made of wood, with the moving parts in brass or iron. A strong pressure will spring it slightly, and I think it would have been better if the frame had been made of iron. The large screw is not equally well cut throughout its length, one thread being especially defective. The carriage is supported on two wheels on one side, and the third wheel on the other side can be raised or lowered, in order to get the arms perfectly horizontal. It runs on two tracks, one of which is grooved (for the two wheels) and the other is plane.

Five minutes is about the shortest time in which two persons can safely reverse the instrument.

In ordering a circle from the REPSOLDS it is important to have them specify the exact free space between the casings of the piers.

THE OBSERVING CHAIR.

The style of this may be seen from the photographs of the Strassburg circle.

With the smaller circles the use of a diagonal eyepiece does away with the necessity for a chair in great measure. I have two sets of 3 steps, 24 inches high and narrow enough to go between the piers. These are needed to read the collimator levels with, and they replace an observing chair for all stars of high elevation. The chair may be found very convenient for the observation of stars in a zone, but for general purposes I consider it inferior to that arranged by Professor HARKNESS for the Naval Observatory Transit Circle.

THE PIER-HEADS.

On the top of the piers two plates of iron are bolted, and on these, supported by three screws, rest the circular microscope bearers. The pier heads, as we may call the iron base plates, should have been planed on the bottom. My brick piers were far more nearly plane surfaces than the bottoms of these bases, when they were received. I had them planed, however, at the University machine shop, and they would then stay in the positions given to them by the adjusting screws, and not rock to and fro. The microscope bearers can be pushed east and west by two opposing screws, and they can be pushed north and south, also, by four such screws. Three screws at the bases of the microscope bearers are provided for the adjustment in level.

HOLDERS FOR THE DECLINATION CLAMP AND SLOW MOTION.

In our circle they are screwed to the base plates of the microscope bearers by two iron hangers.

The iron pier heads are fastened to the brick piers by two iron plates which are held by nuts to two bolts set, one in each pier, solidly in the brick. I have used plaster of Paris

for setting these and for fastening the Ys of the collimators also. As the piers were thoroughly dry, I found it necessary to moisten the brick work before putting it in the plaster.

These bolts should be set as low as possible, as they cast a shadow on the mirror for illuminating the setting microscope and they should have been countersunk in their plates.

THE YS FOR THE COLLIMATORS.

The Ys for the collimators should have had their bases planed. As a matter of fact the only difficulty I have had with the mounting of the whole circle arose from the fact that I attempted to mount the Ys without having previously planed these surfaces. The Ys are provided with all necessary adjustments in level and azimuth, and the whole collimator as mounted, is a great advance upon the REPSOLD collimator described in the *Astronomische Nachrichten* No. 1033.

COLLIMATORS.

There are two collimators exactly alike. The objectives are by MERZ 2.63 inches (67 m. m) in aperture. The eyepieces sent with these magnified 48 diameters and the probable error of a single setting of one collimator on its opposite was 0″.2. I have replaced the original eyepieces by two made by KAHLER, of Washington, which magnify 65 diameters. The probable error of a single setting is now 0″.08 and the setting is done in half the time. Here as in many other cases, the saving of time goes with the increase of precision. I have marked the collimators X and Y. They should have been marked by the maker, as well as the microscopes, eyepieces, etc.

Also it was necessary to provide two caps to fit over the eyepieces, so that the light from the gas-flame should pass through oiled paper before entering the field of view.

The collimators are provided with four stops, 90° apart, which abut against a small lever adjustable in length. In this way it is easy to rotate the collimators about their optical axes through angles of 90° or 180°.

The pivots of the collimators are 3.88 inches in diameter, and are at the very ends of the tube, which is a good plan,

as the objective and the threads are respectively directly over the Ys in a vertical plane. The pivots are kept always free from dust by two covers on the Ys of the collimator levels. I have had plate glass hoods made for the two collimators. The distance between the bearing points of the pivots is about 24.6 inches. All the bearing surfaces of the Ys of both collimators and instrument are made of softer metal, so that these will wear and not the pivots themselves.

The bearings are not surfaces but lines. Two abutting-screws (moving north and south) keep each collimator in its place. Each collimator presses with a weight of about $4\frac{1}{2}$ pounds on each Y. There is an adjustment to this.

The difference of the objective pivot and of the eyepiece pivot of each collimator was determined by levels taken in reversed positions.

The pivots of collimator X are of exactly the same size.

The objective-end pivot of collimator Y is smaller than the eye-end pivot by $0.''19 \pm 0.''06$.

The linear difference in diameters corresponding to $0.''19$ is 0.000016 inches.

The observations upon which these results depend are given in the following paper by Miss ALICE SANBORN, one of my students.

"In the following investigation the collimators designated X and Y belong to the Repsold Meridian Circle of the Washburn Observatory. They are of brass, mounted upon brick piers, 59.06 inches from the floor, in cast iron Ys. The extreme length of each collimator is 25.4 ± inches and the length between the bearings 24.6 ± inches. The diameter of the pivots is 3.88 ± inches.

The levels used are numbered 1399 and 1396. The length of the former, between bearings, is 24.64 inches and of the latter, 24.61 inches. The angle of the Level Ys and the Ys in which the collimators rest were found upon examination to be equal, and each measured 90°.

The determinations of the inequality of pivots of the collimators X and Y are in *two* sets of sixteen determinations each. Eight determinations were obtained with Level No. 1396 and eight with Level No. 1399. During the first set

Collimator Y was on the North Pier and Collimator X on the South Pier. For the second set this order was reversed. Care was taken in all minor details of the operation to insure accurate results. The Ys of the levels, and the pivots and Ys of the collimators were thoroughly wiped before each day's determinations. In the second set of measures special precaution was taken to place the collimators in the Ys with the micrometer threads vertical for the first determination and horizontal for the second, in order that inequalities of both the horizontal and vertical diameters should be eliminated. The levels used were parallel to their axes.

One division of Level 1396 is equal to 1.″29. One division of Level 1399 is equal to 1.″45.

For the notation used in the following tables, and formula to obtain the inequality of pivots, see CHAUVENET'S *Spherical and Practical Astronomy*, Vol. II, §137."

See the tables which follow.

To sum up, the results of the two sets of determinations are:

1st set	Col. X	Level 1396	$p = -0''.054 \pm 0''.042$
	Col. X	Level 1399	$p = +0''.106 \pm 0''.046$
2d set	Col. X	Level 1398	$p = +0''.095 \pm 0''.062$
	Col. X	Level 1399	$p = +0''.064 \pm 0''.078$
		Mean value,	$p = +0''.053 \pm 0.0294$

That is, these pivots are equal.

1st set	Col. Y	Level 1396	$p = +0''.337 \pm 0''.051$
	Col. Y	Level 1399	$p = +0''.130 \pm 0''.048$
2d set	Col. Y	Level 1396	$p = +0''.160 \pm 0''.004$
	Col. Y	Level 1399	$p = +0''.127 \pm 0''.056$
		Mean value,	$p = +0''.191 \pm 0.0275$

That is, the object-end pivot is smaller than the eye-end pivot by $0''.19$.

The linear difference of the radii of the pivots is deduced from the formula given by CHAUVENET, Vol. II, § 140. The mean of the values for inequality thus obtained, are: for collimator X +0.00000445 inches and for collimator Y +0.0000161 inches, which shows the perfection of the workmanship.

The north collimator reticle is north of the circle 8.2 feet, and the reduction is $\Delta\varphi = -0''.11$ The south collimator has a reduction of $\Delta\varphi = +0''.11$.

Date.	Level No.	Objective.	+Means N. end high.		+Means obj. pivot small.		Level Constant. b=B+p. b′=B′−p.	
			Objective N. B.	Objective S. B′.	$p^{d}=\frac{1}{4}(B'-B)$.	p″	b^{d}	b″
1883.								
January 19...	1396	N.	−0.250	.....			b =−0.18	−0.23
		S.	.....	+0.050	+0.07	+0.09	b′=−0.02	−0.03
		S.	.....	+0.700			b =+0.49	+0.63
		N.	+0.425	.....	+0.07	+0.09	b′=+0.63	+0.81
		N.	+0.050	.....			b =−0.03	−0.04
		S.	.....	−0.275	−0.08	−0.10	b′=−0.19	−0.25
		S.	.....	−0.900			b =−0.16	−0.21
		N.	+0.075	.....	−0.24	−0.31	b′=−0.66	−0.85
January 29...		N.	+4.900	.....			[b =+4.76]	[+6.14]
		S.	.....	[+4.350]	[−0.14]	[−0.18]	[b′=+4.49]	[+5.79]
		S.	.....	+3.975			b =+3.96	+5.11
		N.	+3.950	.....	+0.01	+0.01	b′=+3.96	+5.11
		N.	+3.975	.....			b =+4.05	+5.22
		S.	.....	+4.300	+0.08	+0.10	b′=+4.22	+5.44
		S.	.....	+3.950			b =+4.25	+5.48
		N.	+4.350	.....	−0.10	−0.13	b′=+4.05	+5.22

$0^{d}.401$ $\quad -0''.054 \pm 0.042$

Probable error of single determination $=0''.120$.

COLLIMATOR X.—First Series.

Date.	Level No.	Objective.	+Means N. end high.		+Means obj. pivot small.		Level constant. b=B+p b′=B′−p	
			Objective N. B.	Objective S. B′.	$^{d}p=\frac{1}{4}(B'-B)$	p″	b^{d}	b″
1883.								
January 11...	1399.	N.	+2.075	.....			b =+2.07	+3.00
		S.	.....	+2.075	0.00	0.00	b′=+2.07	+3.00
		S.	.....	+1.450			b =+1.16	+1.68
		N.	+1.075	.....	+0.09	+0.13	b′=+1.36	+1.97
		N.	+1.275	.....			b =+1.15	+1.66
		S.	... .	+0.800	—0.12	—0.17	b′=+0.92	+1.33
January 15...		S.	.....	+2.475			b =+1.53	+2.22
		N.	+1.225	.. ..	+0.31	+0.45	b′=+2.16	+3.11
January 16...		N.	+0.425	.....			b =+0.56	+0.81
		S.	.....	+0.975	+0.14	+0.20	b′=+0.83	+1.20
		S.	.....	+0.450			b =+0.24	+0.35
		N.	+0.175	.....	+0.07	+0.10	b′=+0.38	+0.55
		N.	+0.050	.....			b =+0.11	+0.16
		S.	....	+0.300	+0.06	+0.08	b′=+0.24	+0.35
January 29...		S.	.....	+3.950			b =+3.84	+5.57
		N.	+3.800	.....	+0.04	+0.06	b′=+3.91	+5.67

$^{d}+0.074$ $+0''.106 \pm 0''.046$.

Probable error of single determination, $\pm 0''.129$

COLLIMATOR X—SECOND SERIES.

Date.	Level. No.	Objective.	+Means N. end high.		+Means obj. pivot small.		Level Constant. b=B+p b′=B′−p	
			Objective N. B.	Objective S. B′.	[d] p=¼(B′−B)	p″	[e] b	b″
1883.								
February 28..	1399.	N.	−2.875	.....			b =−2.69	−3.90
		S.	.....	−2.150	+0.18	+0.26	b′=−2.33	−3.38
		S.	.....	−2.350			b =−2.09	−3.07
		N.	−2.000	.....	−0.09	−0.13	b′=−2.26	−3.28
March 5.....		N.	−0.525	.....			b =−0.65	−0.94
		S.	.....	−1.050	−0.13	−0.19	b′=−0.92	−1.33
		S.	.....	−0.900			b =−1.09	−1.58
		N.	−1.150	.....	+0.06	+0.08	b′=−0.96	−1.39
March 6.....		N.	−0.000	.....			b =−0.02	−0.03
		S.	.....	−0.100	−0.02	−0.03	b′=−0.08	−0.12
		S.	.....	+0.025			b =−1.53	−2.22
		N.	−2.050	.....	+0.52	+0.75	b′=−0.49	−0.71
March 7.....		N.	−4.600	.....			b =−4.48	−6.50
		S.	.....	−4.125	+0.12	+0.17	b′=−4.24	−6.15
		S.	.....	−4.450			b =−3.50	−5.07
		N.	−3.225	.....	−0.28	−0.40	b′=−4.27	−6.19

[d] +0.045. +0.″064 ± 0″.078.

Probable error of single determination, 0.″220.

COLLIMATOR X—SECOND SERIES.

Date.	Level No.	Objective.	+ Means N. end high.		+ Means obj., pivot small.		Level Constant. b=B+p b′=B′−p	
			Objective N. B	Objective S. B′	$p^{d}=\frac{1}{4}(B'-B)$	p''	b^{d}	b''
1883.								
February 28..	1396	N.	−3.075	.....			b =−3.19	−4.11
		S.	....	−3.550	−0.12	−0.15	b′=−3.43	−4.42
		S.	.....	−2.825			b =−3.59	−4.63
		N.	−3.851	.....	+0.26	+0.34	b′=−3.08	−3.97
March 5.. ...		N.	−0.375	.....			b =−0.38	−0.49
		S.	.....	−0.400	−0.01	−0.01	b′=−0.39	−0.50
		S.	.....	−0.350			b =−0.99	−1.28
		N.	−1.200	.....	+0.21	+0.27	b′=−0.56	−0.72
March 6.....		N.	−0.825	....			b =−0.81	−1.04
		S.	.....	−0.775	+0.01	+0.01	b′=−0.78	−1.01
		S.	.....	−0.550			b =−0.47	−0.61
		N.	−0.450	.....	−0.02	−0.03	b′=−0.53	−0.68
March 7.....		N.	−4.450	.....			b =−4.57	−5.89
		S.	.....	−4.950	−0.12	−0.15	b′=−4.83	−6.23
		S.	.....	−3.850			b =−4.98	−6.42
		N.	−5.350	.....	+0.37	+0.48	b′=−4.22	−5.44
					$+0.^{d}072$	+0.″095 ± 0.″062		

Probable error of single determination, 0.″155.

COLLIMATOR Y — FIRST SERIES.

Date.	Level No.	Objective.	+ Means N. end high.		+ Means obj., pivot small.		Level Constant. b=B+p b′=B′−p	
			Objective N. B.	Objective S. B′.	$p^{d}=\frac{1}{4}(B'-B)$	p″	b	b″
1883.								
January 17...	1396	N.	−0.750	.....			b = −0.45	−0.58
		S.	.....	+0.450	+0.30	+0.39	b′ = +0.15	+0.19
		S.	.....	+0.500			b = −1.12	−1.44
		N.	−0.800	.....	+0.32	+0.41	b′ = +0.18	+0.23
		N.	−1.225	.....			b = −0.79	−1.02
		S.	.....	+0.500	+0.43	+0.55	b′ = +0.07	+0.09
		S.	.....	+0.375			b = −0.73	−0.94
		N.	−1.100	.....	+0.37	+0.48	b′ = +0.00	0.00
January 18...		N.	−1.350	.....			b = −0.99	−1.28
		S.	.....	+0.100	+0.36	+0.46	b′ = −0.26	−0.34
		S.	.....	−0.525			b = −0.67	−0.86
		N.	−0.725	.....	+0.05	+0.06	b′ = −0.57	−0.74
		N.	−0.600	.....			b = −0.64	−0.83
		S.	.....	−0.750	−0.04	−0.05	b′ = −0.71	−0.92
		S.	.....	+0.275			b = −0.66	−0.85
		N.	−0.975	.....	+0.31	+0.40	b′ = −0.03	−0.04

Probable error of single determination. 0″.144 $+0^{d}.262$ +0″.337 ± 0″.051

Date.	Level No.	Objective.	+Means N. end high.		+Means obj. pivot small.		Levél Constant. b=B+p. b′=B′—p,	
			Objective N. B.	Objective S. B′.	$p^{d}=\frac{1}{4}(B'-B)$	p''	b^{d}.	b″.
1883.								
January 8....	1399	N.	—2.025	.....			b =—2.02	—2.93
		S.	.....	—1.975	+0.01	+0.01	b′ =—1.99	—2.88
		S.	.....	—1.925			b =—2.10	—3.04
		N.	—2.175	.....	+0.08	+0.11	b′ =—2.01	—2.91
January 9....		N.	—3.025	.....			b =—2.84	—4.12
		S.	.....	—2.300	+0.18	+0.26	b′ =—2.48	—3.59
		S.	.....	—2.875			b =—2.98	—4.32
		N.	—3.025	.....	+0.04	+0.06	b′ =—2.91	—4.22
January 10...		N.	—3.025	.....			b =—3.05	—4.42
		S.	.....	—1.625	+0.36	+0.52	b′ =—1.98	—2.87
		S.	.....	2.950			b =—2.63	—3.81
		N.	—2.525	.....	−0.11	−0.16	b′ =—2.84	—4.12
		N.	—3.000	.....			b =—2.84	—4.12
		S.	.....	2.350	+0.16	+0.23	b′ =—2.19	—3.17
January 15...		S.	.....	2.500			b =—2.69	—3.90
		N.	—2.750	.....	+0.06	+0.08	b′ =—2.56	—3.71

$+0^{d}.097$ $+0.''139 \pm 0.''048$

Probable error of single determination $=0''.136$.

COLLIMATOR Y.—SECOND SERIES.

Date.	Level No.	Objective.	+Means N. end high.		+Means obj. pivot small.		Level Constant. b=B+p b′=B′−p	
			Objective N. B	Objective S. B′	$p^{d}=\frac{1}{4}(B'-B)$	p''	b^{d}	b''
1883.								
March 1.....	1399	N.	+3.775	.....			b =+3.84	+5.57
		S.	.....	+4.050	+0.07	+0.10	b′=+3.98	+5.77
		S.	.....	+4.275			b =+3.54	+5.13
		N.	+3.300	.....	+0.24	+0.35	b′=+4.03	+5.84
March 5.....		N.	+1.375	.....			b =+1.32	+1.91
		S.	.....	+1.175	−0.05	−0.07	b′=+1.22	+1.77
		S.	.....	+1.525			b =+0.94	+1.36
		N.	+0.750	.....	+0.19	+0.27	b′=+1.33	+1.93
March 6.....		N.	+1.250	.....			b =+1.15	+1.67
		S.	.....	+0.850	−0.10	−0.14	b′=+0.95	+1.38
		S.	.....	+0.225			b =+0.48	+0.70
		N.	+0.575	.....	−0.09	−0.13	b′=+0.31	+0.45
March 7.. ...		N.	−0.725	.....			b =−0.62	−0.90
		S.	.....	−0.325	+0.10	+0.14	b′=−0.42	−0.61
		S.	.....	0.000			b =−1.05	−1.52
		N.	−1.400	.....	+0.35	+0.50	b′=−0.35	−0.51

p^{d} +0.089 p'' +0.″127 ± 0.″056

Probable error of single determination, 0.″158.

COLLIMATOR Y—SECOND SERIES.

Date.	Level No.	Objective.	+Means N. end high.		+Means obj. pivot small.		Level Constant. $b'=B+p$ $b'=B'-p$	
			Objective N. B.	Objective S. B'.	$p^d=\frac{1}{4}(B'-B)$	p''	b^d	b''
1883.								
March 1.....	1396.	N.	+3.675	.....			b = +4.25	+4.48
		S.	.....	+6.000	+0.58	+0.75	b' = +5.42	+6.99
		S.	.....	+5.675			b = +4.87	+6.28
		N.	+4.600	.....	+0.27	+0.35	b' = +5.40	+6.97
March 5.....		N.	+1.075	.....			b = +1.08	+1.39
		S.	.....	+1.100	+0.01	+0.01	b' = +1.09	+1.41
		S.	.....	+1.425			b = +1.11	+1.43
		N.	+1.000	.....	+0.11	+0.14	b' = +1.31	+1.69
March 6.....		N.	+1.000	.....			b = +1.01	+1.30
		S.	.....	+1.025	+0.01	+0.01	b' = +1.01	+1.30
		S.	.....	+0.700			b = +0.70	+0.90
		N.	+0.700	.....	+0.00	+0.00	b' = +0.70	+0.90
March 7.....		N.	−1.425	.....			b = −1.40	−1.81
		S.	.....	−1.325	+0.02	+0.03	b' = −1.34	−1.73
		S.	.....	−0.950			b = −0.91	−1.17
		N.	−0.900	.....	−0.01	+0.01	b' = −0.94	−1.21

^{d}+0.124 +0″.160 ± 0″.064

Probable error of single determination, 0″.180

THE MICROMETERS OF THE COLLIMATORS.

These have adjusting screws (*a*) to rotate the box to make the wires vertical; (*b*) to alter the collimation of the movable wires; (*c*) to alter the collimation of the fixed wires. Also a screw to move the eye piece nearer to, or farther from, the objective.

The micrometer heads are divided into 100 parts, and every 10th part is numbered 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. There is no comb-scale of whole revolutions. The screws are not moved by turning a micrometer head; but the head is geared into a toothed-wheel, which projects from out the recess of the eye-end. This wheel can be moved by the finger with great delicacy. One revolution is equal to 70″.48 for collimator Y, and 70″.44 for X. There are 10 screw threads to each 2.15 m.m.

RETICLES OF THE COLLIMATORS.

I had ordered two glass reticles (which were made for me by Professor ROGERS of the Harvard College Observatory) to be inserted by the Messrs. REPSOLD. They have an insuperable objection to glass reticles of all kinds, and while the glass reticles which I sent, were duly inserted, they also put in a very excellent reticle of spider lines. As both reticles could not be in the same plane they sacrificed the glass one. But it was possible, by reducing the length of the eye-piece tube to provide for seeing either of the reticles at will by simply changing the focus.

The glass reticles are precisely similar to those described by Prof. ROGERS in the *Annals of the Harvard College Observatory*, Vol. X, page XIV.

The spider line recticles consist of two fixed wires and of two movable ones. The distance of the fixed wires is 1.349 rev. ± 0.00008 rev. (112″.3) for Y, and 1.300 rev. ± 0.0008 rev. (111″.6) for X, and the distance of the movable wires is about 0.28 rev. (19″.6).

The spider line recticles of the two collimators are exactly alike. The lines of the glass recticles were not filled with plumbago by the REPSOLDS.

THE LEVELS.

The collimator levels are alike and are numbered R. (epsold) 1396 and R. 1399 respectively. Each bubble is divided on the glass into 62 equal parts and numbered 0, 10, 20, 30, 40, 50, 60. The hanging level is similar to the others.

The value of a division of the bubbles was given me by the REPSOLDS as below:

	Hanging Level;	R. 1396;	R. 1399
One Division=	1″.22	1″.27	1″.28

Determinations have been made here as follows:

Hanging Level:

1883	Jan. 5	1″.20±0.012;	t°=44°;	E. S.H.	from the circle.	
	9	1 .20±0.008;	=42 ;	"	" " "	
	June 9-16	1 .29±0.005;	= ? ;	G.C.C.	"	Ast. Nach. No. 2490.
1884	Feb'y 7	1 .28±0.009;	=27 ;	J. T.	"	Z. D. Micrometer.
	13	1 .22±0.007:	=20 ;	J. T.	"	the circle.
	Feb'y 15	1 .31±0.003;	=15 ;	J. T.	"	Z. D. Micrometer.

Two determinations in January were made with the bubble attached to its frame. The determinations of June and February required that the level should be dismounted from its frame. It appears probable that this operation in June altered the bearings of the level bubble in the Y's of its case.

The determination of June 9–16 was made by the method of Dr. BRAUN described in *Ast. Nach.* 2490. The level-constant of the circle has not been above 2 div. and the uncertainty in the value of the level-constant has therefore always been less than 0.01.

R. 1396:—This level has not been changed in adjustment since it was received. The value of one division has been found:

1883	Jan 9.	1″.31;	t°=42°;	E.S.H.	from the circle.
	10.	1 .29;	=45°;	"	" " "
	30.	1 .28;	=47 ;	"	" " "
Adopted		1 .29	at 45°		

R. 1399—This bubble was turned slightly in its Y's and readjusted in December 1882. The value of one division has been found:

1883	Jan. 10.	1″.41;	t°=47°;	E.S.H.	from the circle.
	10.	1 .45	=47 ;	"	" " "
	30.	1 .49	= ? ;	"	" " "

An examination of this level in September 1883 led me to believe that the tube was under some slight strain and it was removed from its bearings and readjusted.

From three days (30 observations) Mr. TATLOCK found:

One division $= 1''.225 + 0''.01\ (t—32°)$.

It is clear that these levels require great care in placing them in their own Ys, in leaving equal portions of the ends projecting beyond the Ys etc. When this care is taken they give remarkably consistent results, and are truly instruments of precision, as so many levels are not.

The hanging level gives the same value of the level constant as the nadir observation.

Each collimator level is provided with a cross level. The most delicate of these has 1 inch$=107''\pm$. This seems to me too delicate. The level tubes are closed at the ends by melting the glass itself. This should obviate all leakage. Each has an air chamber. The value of one division of the collimator levels can be easily determined by setting them astride of the tube of the telescope and reading the levels as the telescope is moved in declination. Singularly enough, it is almost impossible to find a good way to attach the hanging level to the telescope or circles in order to determine the value of *its* divisions without detaching the bubble from the frame. In fact this was done January 5 and 9 by clamping a wooden axis to the upper part of the declination clamp, and removing the hand-circle to give room. By making two round surfaces on the handles which hold the illumination rods, the determination would have been made much easier. I have asked the makers to do this in a circle they are constructing for the Lick Observatory.

A very excellent device which cannot be explained without a wood cut insures that the levels should bear on the pivots with considerably less than their full weight. Incidentally this counterpoising gives a warning of the moment before the V's of the level touch the pivots and insures careful handling. Clamping the telescope has no effect on the level.

EYE-PIECES OF THE MERIDIAN-CIRCLE.

A box of five eye-pieces, two sun glasses and a reflecting nadir cap (BESSEL's form) was received from the makers. This last was especially ordered. The eye-pieces I have marked I, II, III, IV and V (diagonal). The powers and fields are as below:

I	power = 68	field = 27′.9
II	= 102	= 19 .1
III	= 144	= 12 .2
IV	= 174	= 9 .2
V	= 119	= 10 .9

IV is generally used in observation.

The sunshades *screw* on the eye-pieces instead of fitting (slipping) over the end. The dark glasses are also tightly reamed into their cells and will therefore eventually break. The eye-pieces were ordered to be made Steinheil achromatics. They have been made after that formula, but *the fields are not flat.* I have replaced IV by a genuine Steinheil.

THE OBJECT-GLASS AND ITS ADJUSTMENT.

This was made by ALVAN CLARK & SONS. It has a clear aperture of 4.80 inches, and a focus of 57.6 inches. The *minimum visibile* in a dark field is theoretically 12.6 mag. In a bright field it is practically 9.0 mag. with the spider-line recticle, and probably about 8.5 with the glass-recticle.

In March 1883, while I was absent, Mr. COMSTOCK focused the objective on the images of the wires seen in the Nadir-box. After my return in July 1883, the instrument was employed only in A. R. observations until August. Daily determinations of the Nadir, etc., were made by Mr. TATLOCK, assistant, as exhibited in the tables at the end of this paper. After August 28, to test the question of focal adjustment, the Nadir was determined in three ways at each convenient occasion:

1st, with the whole aperture.

2d, with the objective covered by a lune-shaped cap, with its aperture *north.*

3d, with the same cap with its aperture *south*.

This cap was made from a piece of card-board which was first cut into a circle of the same size as the objective. Then a circle was described from a point of the outer curve of the pasteboard circle as a center, which had the same radius as the objective. Then the portion of the pasteboard lying between the two circumferences, was removed. This left a lune-shaped aperture whose bounding curves were both concave towards its centre. This opening was turned alternately north and south. The results of the first determinations (August 28 — September 5), were regarded as unsatisfactory, (see the table immediately following) although the images of the wires were good, and the images of stars were not noticeably bad, though not entirely satisfactory. I then changed the focus slightly. The observations of September 8, 11, 12, correspond to the change. I then arranged a mark south of the south collimator (a printed notice) so that it could be seen in the telescope of the circle after its rays passed through a large lens of ten inches focus. The cap was then moved so that the lune took the four positions, cap *up*, *down*, *right*, *left*, and the objective and its cell was so tilted that the image of the printed letters was the same in all positions of the cap, and also with the full aperture. I found that the objective needed a very considerable change to produce this result. It then gave good images of stars. The measures of September 16, 19 and 21 were taken in this state of the objective.

The first six measures give in the mean, Free objective *minus* $\frac{1}{2}$ (Lune N. + Lune S.) = +0.″22. The last three give for the same quantity + 0.″03. At the time this was regarded as a proof that the latter state of the objective was an improvement over the first, especially as the images of stars were then satisfactory.

In April, 1884, however, I began a series of observations of the 303 fundamental stars of the Astronomische Gesellschaft, and I found the images of stars were very unsatisfactory at this time, although there had been no change of the objective. An examination of the objective led me to

the conclusion that tilting it, by the insertion of pieces of card board between the base of the cell and the face-plate of the tube (which I had been obliged to resort to in the absence of adjusting screws for the cell) had slightly strained the lenses. The card board was at once removed and the cell was replaced in very nearly its original state. The images of stars were improved by tightening some of the screws of the cell and they are now (May, 1884) tolerably good.

A wing on one side of the image still remains, which could be removed in five minutes were the necessary adjusting screws available from the outside. The nadir points with the whole objective and from the means of the lunes now agree within 0.″2 and considering the difficulty of determining the nadir with the lune shaped aperture, I am now disposed to consider this satisfactory, which I was not at first.

It is my opinion that all objectives as large as 4.5 inches and upwards should be mounted so that 3 binding and 3 opposing screws (in pairs) are easily reached from the outside for their adjustment. No objective can stay in perfect adjustment forever, no matter how mounted.

If then it has to be corrected, some convenient means for doing this should be provided.

NADIR-POINTS; DETERMINED WITH AND WITHOUT THE LUNE-SHAPED CAP.

1883.	Aug. 28.	Aug. 30.	Sept. 5.	Sept. 6.	Sept. 8.	Sept. 11.	Sept. 12.	Sept. 16.	Sept. 16.	Sept. 19.	Sept. 21.
					Focus altered Slightly.			**Whole objective Altered.**			
Lune S....	35″.76	35″.70	——	36″.22	34″.57	35″.08	35″.44	——	34″.62	34″.60	34″.57
Lune N...	35.01	35.18	——	35.45	34.26	34.25	34.68	——	34.68	34.43	34.35
Free Objective .	35.82	35.57	36.29 .41 .19	35.97	34.40	34.93	35.47	34.86* 35.03* 34.78*	34.39	34.70	34.63
O. G.—N..	+0.81	+0.39	——	+0.52	+0.14	+0.68.	+0.79	——	−0.29	+0.27	+0.28
O. G.—S..	+0.06	−0.13	——	−0.25	−0.17	−0.15	+0.03	——	−0.23	+0.10	+0.06

The observer throughout is TATLOCK except those observations marked *, when it is COMSTOCK.
The probable error of a single determination of the Nadir point has (elsewhere) been shown to be ±0″.15.

We have not yet examined the question as to whether the Nadir point is the same when the telescope is turned from the north to the Nadir or from the south to the Nadir.

To protect the mercury in the Nadir-box against currents of wind in the room, I use a screen of 2 joints of tin furnace pipe 12 inches in diameter, and find advantage from this.

The Chicago, Milwaukee & St. Paul R. R. has a track within 1,200 feet of the observatory, and the passage of a train interrupts all reflection observations for 5 minutes. But little inconvenience has so far been experienced from this.

ILLUMINATION OF THE FIELD OF VIEW IN THE DETERMINATION OF THE NADIR-POINT.

The general practice is, I believe, to employ a cap over the eye-piece which has a plane glass reflector above it. The image of a lamp flame is reflected into the field and on this image the position of the reflected wire is measured. The field is of various brilliancy in different parts, owing to the reflection from the two surfaces of the glass, etc., and this is often annoying and always fatiguing to the eye. I have found that by interposing a screen of ground glass, or even one or two thicknesses of oiled silk, between the flame and the reflector, a uniformly illuminated field is obtained, and the improvement is so great that I think it worth while to mention it here.

THE MICROMETER OF THE CIRCLE.

The micrometer is, in general, a beautiful piece of design. To fully comprehend it, a figure should be given, which I have no way of producing here. The general principles of this form are the same as those which have been explained by Mr. DAVID GILL, in Vol. II, of the Dun Echt observations, and more specifically in the Encyclopædia Britannica, volume XVI, page 246, *et seq.* Figures 16 and 17 of that work give the essential features of our Z. D. micrometer. Figure 14 applies to the micrometers of the microscopes. I entirely agree with Mr. GILL in his admiration for the very elegant design and workmanship of these instruments. I may therefore content myself with pointing out some of the special

features of the exterior, and as usual, I shall speak most of the faults, as they appear to me.

The R. A. micrometer has no way of counting whole revolutions. This is always an inconvenience, and will be especially so in this case, where it is proposed to move the whole reticle (of glass) and to set it at the zero of collimation. A simple comb-scale would have been sufficient. Both micrometer heads are divided to 100 parts, and numbered 0, 5, 10, 15, 20, etc. That is, every fifth part is *numbered*. Experience has shown that ten parts are easily carried in the head, and I cannot but think that this numbering will produce a number of errors of 0.05 revolutions in the record. After a trial of it, I have had every number ending in 5 painted over in black paint.

The screw heads for giving the slide which carries the eyepiece a rapid movement, are particularly convenient. They consist of a small hexagonal head, which will move quite freely and rapidly between the fingers. The same kind of a head has been applied to the clamp of the main circle in Z. D., and here it is a mistake. Such a form is admirable for a rapid and continuous motion, as in the micrometer, but not at all suited for a motion of a tenth of a turn, such as is required to clamp the circle. In the latter case the object of the makers was evidently to provide against too much power being used on the clamp. Both of the micrometer heads of the eyepiece end have these little hexagonal heads for the purpose of giving a rapid motion to the screws; and for the purpose of making the final, fine setting, they have also milled heads about one inch and a third in diameter. The R. A. micrometer is provided with a clamp by which it can be fixed in any position. The (single) zero mark on the index of the R. A. micrometer, and the corresponding marks on the indexes of two of the microscope-micrometers are straight lines, or nearly so, but they are put on to the indexes so that they must always be *inclined* to the graduation.

On the whole, this micrometer seems to me to be superior in design to any similar one that I have ever seen, and in

particular it is better than the PISTOR and MARTINS micrometer in many essential ways.

One revolution of the Dec. screw is 64.″527, which is fine enough. One revolution of the R. A. screw is $4^s.295 = 64.''43$. Each screw has 10 threads to 4.55 millimeters.

On Dec. 4 and Dec. 5, 1883, Mr. TATLOCK and myself investigated the periodic errors of the Z. D. micrometer for every tenth of a revolution from 4.0 to 15.0, by BESSEL's method. On Dec. 4 a constant space of about 0.5 revolution was measured, and on Dec. 5 a space of 0.25 rev. The results showed the maximum periodic error to be not more than 0″.05. This is less than the least reading of the head ($0^r001 = 0''.06$) and less than the accidental errors of setting, and it will not be taken into account. This result has somewhat surprised me, as the form of mounting gives the errors of the screw their full value, the excellence of this form consisting in the fact that these errors, whatever they are, are *constant*. This determination will be repeated.

VALUES OF ONE REVOLUTION OF THE RIGHT ASCENSION AND ZENITH DISTANCE MICROMETER.

Four series of determinations of the value of 1 revolution of the Z. D. micrometer have been made.

I. Made by Mr. COMSTOCK on April 1st and 27th, 1883. The resulting value, from seven determinations, is, 1 rev. $= 64''.4799 \pm 0''.0026$.

II. Made by Mr. COMSTOCK on June 22d and 23d, 1883. The resulting value, from ten determinations, is, 1 rev. $= 64''.5023 \pm 0''.0044$.

III. Made by Mr. TATLOCK on July 14th and 16th, 1883. The resulting value, from ten determinations, is, 1 rev. $= 64''.4721 \pm 0''.0057$.

IV. Made by Mr. TATLOCK on Sept. 24th, 25th and 27th, 1883. The resulting vale, from twenty determinations, four of weight $\frac{1}{4}$, is, 1 rev. $= 64''.5215 \pm 0''.0075$.

Between the times of these determinations the focus of the telescope was changed, and in order to combine the above values it is necessary to apply a correction to the first three in order to reduce them to the same focus with which IV was determined. The focal length of the telescope is taken as 56.9 inches, the approximate value of 1 rev. of the screw is 64″.5. I. requires to be corrected for a change of the focus

of 0.06 inch, and II. and III. for a change of 0.03 inch, the focus having been shortened 0.06 inches in all.

The corrections to I, III and II, computed from the formula,

$$dr = -64''.5 \frac{df}{56.9}$$

are then

$$\begin{array}{l} \text{I} + 0''.0680 \\ \text{II} + 0\ .0340 \\ \text{III} + 0\ .0340 \end{array}$$

The corrected values of the four determinations are:

I	$64''.5479 \pm 0''.0026$	weight	1
II	$.5363 \pm 0\ .0044$	"	1
III	$.5061 \pm 0\ .0057$	"	1
IV	$.5215 \pm 0\ .0075$	"	2

The adopted value of 1 rev. of the Zenith Distance micrometer is:

$$64''.527 \pm 0''.0025$$

In March April and May 1883, Mr. COMSTOCK determined the value of 1 revolution of the A. R. micrometer screw, from thirty transits of circumpolar stars to be:

$$4\overset{s}{.}2904 \pm 0\overset{s}{.}005$$

As these determinations were made with the same focus as series I of the Z. D. micrometer, and as the values of the two screws are about the same, this value of the A. R. screw requires the correction of

$$+0\overset{s}{.}00045$$

The adopted value of the A. R. micrometer is

$$1 \text{ Rev.} = 4\overset{s}{.}295 \pm 0\overset{s}{.}0005$$

RETICLES OF THE MERIDIAN-CIRCLE.

The REPSOLDS have, as has been said, an insuperable objection to glass reticles, and they inserted spider lines, besides providing for the glass reticles which Professor ROGERS ruled for me. None of the glass lines were filled with plumbago by the REPSOLDS. One serious objection to glass reticles is that, so far as I practically know, a dark field and bright wires can not be obtained. In every other respect they seem to me immeasurably superior to spider lines. The wires are far finer. For example: the spider lines of REPSOLD are

at least three times as thick as the lines of my glass reticle, which (when they are filled with black lead) are of a beautiful fineness, evenness and distinctness. Any amount of work can be put on determining the intervals of a glass reticle, tables may be constructed for these intervals at each 10′ of declination, and so on, since one is sure that it can never be broken except by gross carelessness, whereas spider lines change their distance from time to time (see LEYDEN observations, I p. xcvi for one example), and they perpetually need attention to keep them free of dust, and they are certain to be broken sooner or late.

The operation of replacing them is not easy, even if one has a suitable web. One glass reticle ought to last a hundred years. For reticles where inclined lines, two lines at an angle, etc., are required or convenient, as in some forms of collimator reticles, the glass wires have a greater advantage even.

DETERMINATION OF THE THREAD INTERVALS OF THE RETICLES, BY MISS ALICE SANBORN, STUDENT IN ASTRONOMY.

"The spider line reticle consists of two fixed horizontal guide wires and three parallel threads movable with the declination screw, also 27 fixed perpendicular threads, with one movable thread attached to the Right Ascension screw. For convenience I have lettered the groups of wires from A to G, beginning at the side nearest the Right Ascension screw. I have also numbered the wires of each group, in a like manner, from 1 to 3, 4 or 7, as the case might be. In the follow- measurements of the thread intervals the groups A and G are omitted because the movable thread cannot be brought to them. The coincidence numbers are the mean of two readings which indicate the contacts on both sides of the threads. Five sets of determinations were taken, no two of them upon the same day. Each set consists of 5 coincidences upon each of the 21 threads. So that the mean micrometer reading for each thread is a mean of 25 determinations. The measures were all taken in the daytime, the eyepiece being removed from the telescope and directed towards a window. The screw, when the readings were made, was always placed in the same position with reference

to the direction of gravity. The settings were made by increasing readings of the scale and between the horizontal guide wires.

The measures were taken between December 1st and 20th, 1882. The temperature where the micrometer stood during that time, ranged from 58° to 73° F.

The result of the investigation is summed up in the following table:

Thread.	Mean reading of micrometer.	Distance from Mid. thread (D_4) in screw revolutions.	Thickness of thread in screw revolutions.
F_4	0.592 ± 0.00063	—7.050 ± 0.0007	0.0239 ± 0.0007
F_3	1.057 ± 0.00066	—6.585 ± 0.0007	0.0240 ± 0.0005
F_2	1.527 ± 0.00095	—6.115 ± 0.0014	0.0242 ± 0.0005
F_1	2.006 ± 0.00099	—5.636 ± 0.0010	0.0249 ± 0.0005
E_3	3.878 ± 0.00064	—3.764 ± 0.0007	0.0242 ± 0.0009
E_2	4.348 ± 0.00064	—3.294 ± 0.0007	0.0244 ± 0.0008
E_1	4.822 ± 0.00071	—2.820 ± 0.0008	0.0240 ± 0.0007
D_7	6.704 ± 0.00039	—0.938 ± 0.0005	0.0241 ± 0.0006
D_6	6.930 ± 0.00054	—0.712 ± 0.0006	0.0232 ± 0.0009
D_5	7.170 ± 0.00037	—0.472 ± 1.0005	0.0245 ± 0.0009
D_4	7.642 ± 0.00039	.....	0.0239 ± 0.0009
D_3	8.116 ± 0.00037	+0.474 ± 0.0005	0.0249 ± 0.0006
D_2	8.355 ± 0.00037	+0.713 ± 0.0005	0.0237 ± 0.0009
D_1	8.606 ± 0.00039	+0.964 ± 0.0005	0.0243 ± 0.0005
C_3	10.472 ± 0.00058	+2.830 ± 0.0006	0.0242 ± 0.0005
C_2	10.938 ± 0.00074	+3.296 ± 0.0008	0.0234 ± 0.0005
C_1	11.406 ± 0.00120	+3.764 ± 0.0012	0.0222 ± 0.0006
B_4	13.302 ± 0.00083	+5.660 ± 0.0009	0.0226 ± 0.0007
B_3	13.776 ± 0.00062	+6.134 ± 0.0007	0.0225 ± 0.0005
B_2	14.239 ± 0.00058	+6.597 ± 0.0006	0.0231 ± 0.0006
B_1	14.718 ± 0.00101	+7.076 + 0.0010	0.0230 ± 0.0003

These may be reduced to arc by the relation:

$$\text{One revolution} = 4^{s}.295 \quad \text{in time.}$$
$$= 64.''43 \quad \text{in arc.}$$

The glass reticle was ruled by Professor W. A. ROGERS. It has 21 lines arranged in 5 groups of 1, 3, 13, 3, 1 lines; these groups are called L; M; O; P; Q. The equatorial intervals, as measured with the micrometer screw are:

$$\begin{cases} Q = -20^{s}.06 \\ \left\{\begin{array}{l} P_3 = -12.03 \\ P_2 = -10.10 \\ P_1 = -8.04 \end{array}\right. \\ \left\{\begin{array}{l} O_{13} = -4.04 \\ O_{10} = -2.02 \\ O_7 = -0.00 \\ O_4 = +2.01 \\ O_1 = +3.93 \end{array}\right. \\ \left\{\begin{array}{l} M_3 = +8.02 \\ M_2 = +10.04 \\ M_1 = +12.06 \end{array}\right. \\ L = +20^{s}.10 \end{cases}$$

The spaces between O_1 and O_4, O_4 and O_7, O_7 and O_{10}, O_{10} and O_{13}, are divided into 3 equal parts by short intermediate lines. For *Polaris* these smallest intervals correspond to about 30^{s}."

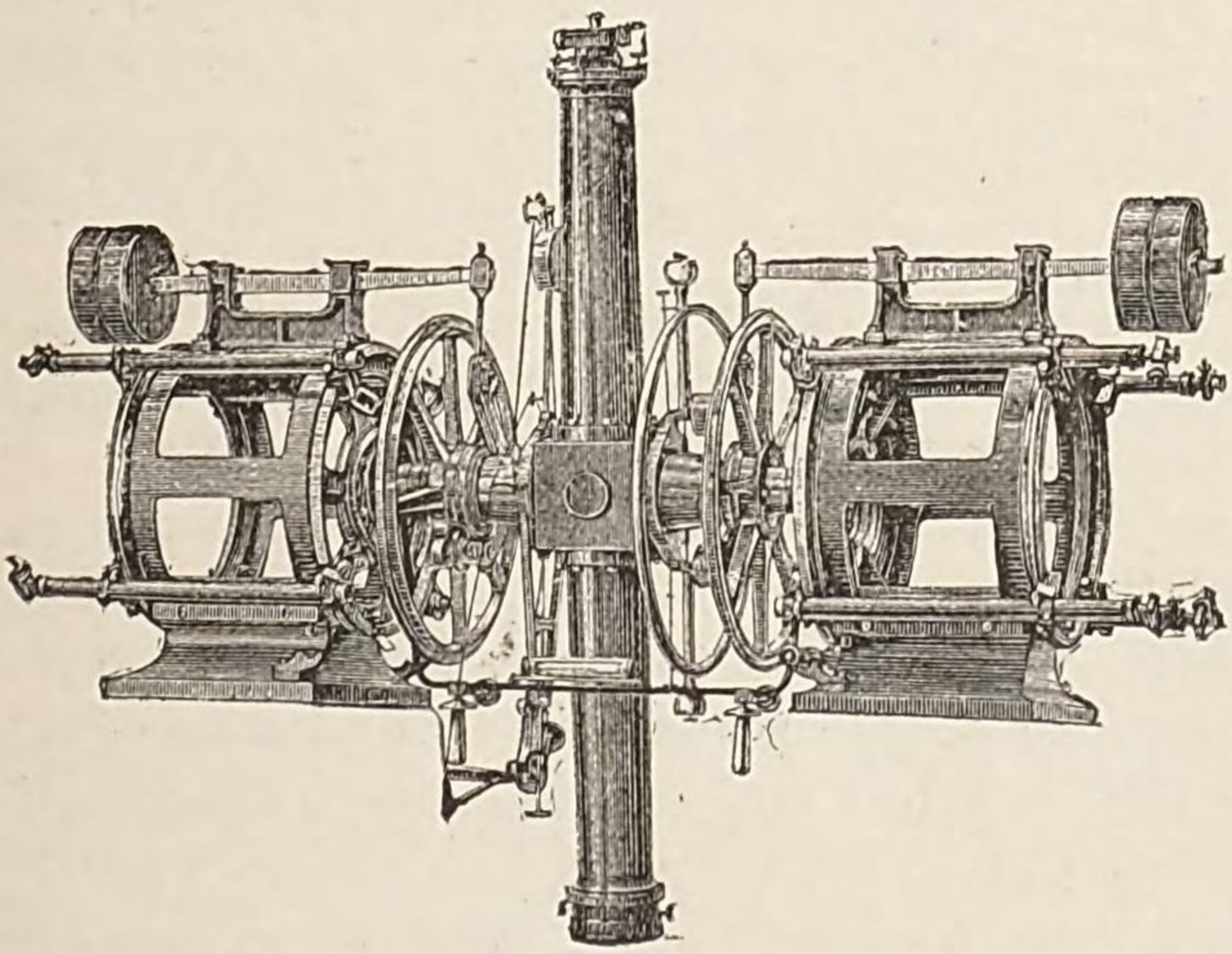
THE DECLINATION CLAMP.

The cut will give a better idea of this than any description. One turn of the slow motion in Declination is 4′ on the circle. The clamp is radial, and its head is hexagonal 0.5 inch in diameter. This head is too small, and I have made it larger by wrapping a wide rubber band about it. Clamping or unclamping has no effect on the pointing, as there is an adjustment by which the slack motion can be taken out.

THE ILLUMINATION OF THE FIELD OF VIEW.

The handles for controlling this are on the side of the telescope opposite to the clamp in declination. Both bright and dark wires are provided for. When the eye and object ends are interchanged, no change is necessary in the illumination arrangements. At least this was the intention of the makers. The probability is, however, that the changed adjustment of the objective will necessitate a change of this sort.

Within the cube is a frame carrying two mirrors. This frame is movable by the handle for bright wires. With *circle east* the beam from the west lamp is reflected by the west mirror to a small circular mirror (0.43 inch in diameter) fastended to the inner surface of the objective, and from this toward the eye-end, giving a bright *field.* If bright *wires* are wanted a few turns of the bright wire handle reverses the mirror-frame and turns the west mirror out of the way of the beam from the west lamp. This beam then falls on the *east* mirror and it is reflected to prisms on each side of the tube near the eye-end, which light the wires symmetrically. Each mirror is adjustable, and the angle through which the mirror-frame rotates is also adjustable. I do not know how the illumination is modified in intensity, as the apparatus is concealed in the cube. It is probably quite simple.



THE AXIS.

The axis consists of one piece of brass (gun metal?) with steel pivots in each end. In the center of the axis is the *cube,* 6.9 inches on each edge. Next to the cube, on each side, is a narrow cylindrical band, which holds the Dec. clamp on one side and the illumination handles and two counterpoises to the clamp on the other. Beyond this is a conical axis J F, J being nearest the cube. The diameter at J on the clamp

side is 5.34 inches, on the other 5.36 inches. (Cl. — O = — 0.02 inches) The diameter at F is clamp side 4.26 inches, other side 4.23 inches (Cl. — O = + 0.03). Beyond F is a cylinder E, on each side, which takes the rolls of the counterweights. The diameters on both sides are 5.96 inches. (Cl. — O = 0.00). The distance from the centre of the cube to these rolls is 9.3 inches; from the rolls to the centre of the bearing surface of the pivots, 5.2 inches. The two circles fit on two slightly conical surfaces C, and rest flat against the outer surfaces of E.

The diameters of C where it joins E, are 4.25 inches on both sides (Cl. — O = 0.00). Beyond C is a conical solid Y Z, Y being nearest the cube. The diameters at Y are, clamp side 3.40 inches, other 3.34 inches, (Cl. — O = + 0.06 in.) The diameters at Z are, clamp side 3.05 inches, other 3.00 inches, (Cl. — O = + 0.05 in.) Beyond Y Z is a cylinder D, of the diameter 3.21 inches on both sides. Into D the pivots are inserted. The apertures in the cube are 3.1 inches in diameter; the collimator objectives are 2.7 inches.

THE TUBE.

The tube is made of two sections of heavy brass, bolted to the cube by eight screws at each section. Each section is 22.8 inches long, the cube being 6.9 inches. Both ends are alike, and the cell of the objective, or the eye-piece can be screwed (by three screws) to either end. The 16 capstan-headed screws which bolt the tube to the cube have holes of *different* sizes. Eleven of them will take the capstan bar sent by the REPSOLDS, and the rest require a smaller bar!

THE PIVOTS.

The steel pivots are beautifully polished, with bearing surfaces 0.9 inches long. Beyond these, nearer the cube, are two unpolished surfaces 0.6 inches long. These last allowed the grinding tool to pass completely off the pivots proper. I have never seen work of the kind more beautiful to the eye. The pivots are protected from dust by brass caps, which are removed for level determinations.

The circle is raised and the pivots examined every Mon-

day. At first I allowed the pivots to run dry. They are now covered with fine watch-oil.

During the winter of 1882–3, one of my students, Mr. C. M. CONRADSON, of the University of Wisconsin, made a very extensive and careful set of measures of the pivots A. and B. A is the pivot next the clamp.

The measures were made with a caliper constructed by FAUTH & Co., of Washington, from the designs of Prof. HARKNESS (Mon. Not. R. A. S. vol. 38, p 487.)

A figure of this is given on the next page.

In the first place, the pivots were proved to be circular, by measures of diameters inclined by angles of 45°. Each pivot was accurately circular. The pivots are very approximately 1.333 inches in diameter.

To determine whether the two pivots were of the same diameter, the following measures were made by Mr CONRADSON. Each line in the table represents 10 measures on A. and 10 on B. There are 200 in all. The measures of each day are given in the following table. + in column 4 indicates Clamp Pivot too small.

1882.	A. Revolutions.	B. Revolutions.	A—B. Revolutions.
December 7.....	0.006389	0.006383	+0.000006
7.....	6312	6386	— 74
8.....	6400	6399	+ 01
11.....	6398	6414	— 16
11.....	6380	6368	+ 12
11.....	6369	6360	+ 09
12.....	6300	6367	+ 67
12.....	6336	6367	— 31
12.....	6340	6354	— 14
12.....	0.006382	0.006379	+0.000003
		Mean	−0.0000171

Let 2i=the angle of the Ys of the caliper=90°.

n=the difference of the spherometer readings on the pivots A and B=$0.0000171^{rev.}$.

r_1, r_2=the radii of the pivots.

Then the inequality of the pivots expressed in revolutions of the spherometer is

$$r_1 - r_2 = \frac{n.\ \sin i}{1+\sin i}$$

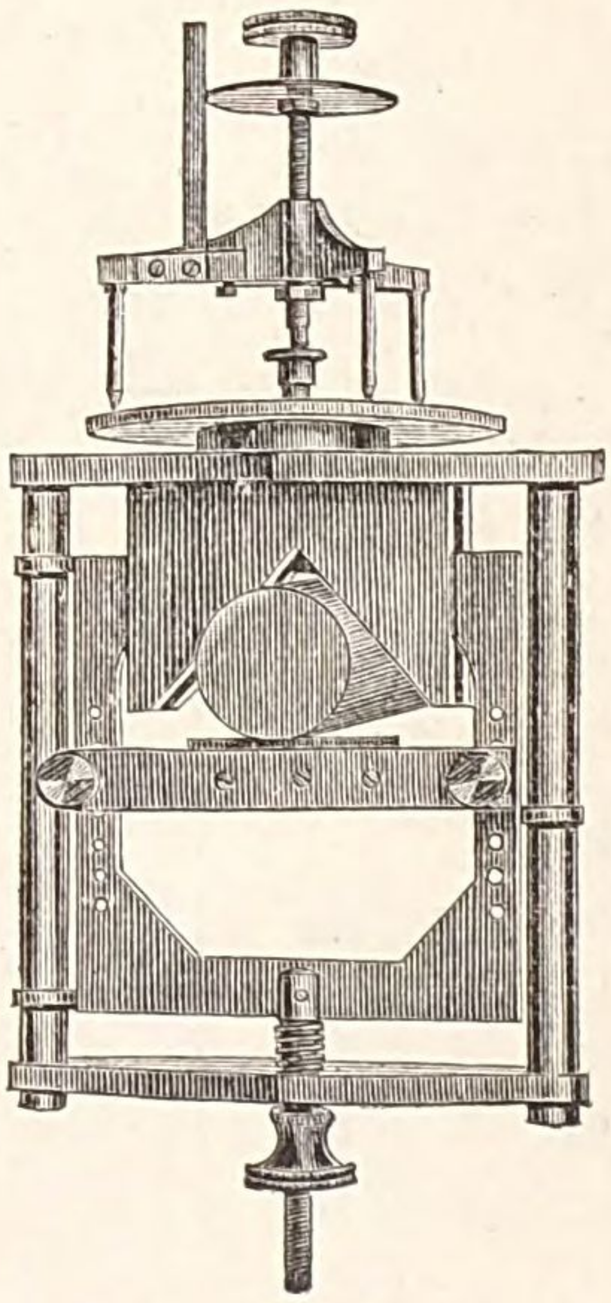
$= 0.414\ n$ in the present case.

$= 0.000007$ revolutions.

inches

One revolution was 0.010017 whence the *indicated* difference of diameters of A and B is 0.000,000,07 inches.

It is clear that there is no measurable difference in these pivots. They are, like nearly every other essential part of the instrument, very near to mechanical perfection.



CIRCLES.

Each circle fits neatly on its bearing (the divided circle the tightest) and is kept in place by a plate or ring of brass which is held by four screws which do not touch the circle itself. Thus the circles can be moved on the axis and they are under no strain. Each circle has eight spokes and the microscope bearers have six. As far as I can see the flexur e of the circles would be less if they were composed of single plates. One circle is divided on silver to 2′. The marks for each degree and for 30′ are of one length; those for 10′ are

shorter; and those for 2′, 4′, 6′ and 8′ are shorter still. The divisions are extremely neat sharp and regular in appearance. The width of each division is about 11″. The width of the divisions of different circles (of various diameters) vary considerably. PISTOR & MARTINS' circle at Washington has divisions 4″ in width. The Harvard College Circle has divisions 12″ wide. The REPSOLD circle at Moscow has divisions 5″ wide. I presume the more oblique illumination of the PISTOR & MARTINS' circle to have something to do with the difference, although the divisions themselves are really far narrower. The probable error of a single microscope setting is 0″.16. This is the same for the long as for the short divisions, at least for myself. Each degree is numbered (this had to be especially ordered) and the numbers are wrong side up. The numeration increases like that of the face of a watch. The diameter of the division is $0^{m}.55$=21.65 inches. 1°=0.189 inches; 2′=0.0068 inches. It required 58 hours to divide the circle.

The division itself is on a narrow band of silver whose surface is approximately flat. On each side of the band is a continuous groove extending all round the circumference. This is probably intended to receive dust, etc., and to keep it away from the divisions.

The circle was not critically examined throughout its arc, until some time had elapsed since the mounting of the instrument. When it was examined (January, 1883) I found a large number of places on the divided limb which showed fine scratches usually not visible in the reading microscopes however. I am not certain, of course, that these were not made here, but the divided circle was not put on the axis till December 1882, and since that time it has been very carefully treated. It was only removed from its box at the time of putting it on. No one of these is more than the finest line, and as I said only one or two are visible (even) in the reading microscopes. I have made a list of the places where they occur, and can by consulting this see if similar ones are produced in the future.

THE HAND-CIRCLE.

This is of round brass tubing made in two halves, which are bolted to squared surfaces on the holder for the illumination-handle.

At first the circle was often moved in Z. D. by taking hold of the eye-end of the tube. Now, the invariable practice is to move it by the hand-circle, and it appears that this custom has slightly improved our declinations.

COUNTERPOISING.

The counter weights (four in number) are held by two levers over the Vs, which rest on knife edges. They have been so adjusted (by a spring-balance) as to leave nearly 12 pounds pressure on each V. In this state, a weight of about one pound applied to either end will just keep the telescope moving. The whole friction is in the Declination arm. If this is put out of gear a few ounces will move the telescope.

CHAINS FOR HOLDING THE COUNTERWEIGHTS.

A criticism which has been made upon the style of microscope holders adopted by the REPSOLDS, is that during reversals the weights above the piers are quite differently disposed from common. To obviate this objection, the makers provided two chains which fasten to the wooden casings (to the W. side of the E. pier and to the E. side of the W. pier), and extend vertically upwards to take hold of two eyes in the under sides of the hooks which hold the friction-rolls. The idea seems to be excellent, but it is a fact that few circles are reversed oftener than once a month, and in my own case I do not propose to reverse oftener than four times per year. In order to be ready for such occasions these chains have to be kept hanging to their fastenings where they are very much in the way, or else they must be newly adjusted for each reversal.

By reversing at the end of one night's work, the piers, etc., will have plenty of time to settle to new and permanent bearings before the next observation. Therefore I have (at least for the present), left off these chains, in order to have the space between the piers clear.

THE PIERS FOR THE INSTRUMENT AND COLLIMATORS.

A plan and an elevation of the piers was furnished by the REPSOLDS and exactly followed throughout.

The order of work was as below: A meridian line was marked on the north and south walls, and perpendiculars to this were marked on the east and west walls. A full size section of the piers was drawn on the west wall and centres carried across to the east wall. The foundations for the piers of the PISTOR and MARTINS Transit belonging to Professor WATSON, were already laid, and these were utilized as a basis for the piers of the REPSOLD meridian circle. 7′ 4″ below the floor a thin bed of concrete had been laid (about 2″ thick). This rested on a level bed of the fine building sand of which the hill is composed. On this concrete was a mass of rubble stone 2′ 6″ high, by 4′ 6″ wide (north and south), by 8′ 10″ long (east and west). On this was a mass of solid brick-work (white Waterloo brick laid in cement), 2′ 0″ × 4′ 6″ × 8′ 6″. Above this was a single granite block, 10″ × 4′ 6″ × 8′ 6″. Up to this point no new work was done. The surface of this stone was cleared off and 3 courses of hard red brick were laid on it. The east and west dimensions were about 8′ 4″. The height was 10″. The width at bottom was 3′ 6″, at top 3′ 0″. The top was 11″ below the floor level.

This whole foundation was surrounded by an open pit some 16″ wide whose bottom was 7′ 4″ below the floor. A 9″ brick wall surrounded this pit. No collimator piers were provided for the old Transit Instrument and these were therefore entirely new. The foundations for the collimator piers start from a plane 8′ 9″ below the floor and are based on a bed of concrete 5″ thick. On top of the concrete (which does not touch any of the walls of the building, nor any of the walls of the well around it) three courses of red brick are laid with the sides vertical. This block is 10″ × 4′ 6″ × 4′ 9″. Above this is a frustum of a pyramid 4′ 6″ square at the bottom and 3′ 3″ square at the top. The top is 11″ below the floor level. Each collimator foundation is in a well, surrounded by a 9″ brick wall, whose bottom is 8′ 9″ below the

floor and whose top is 2′ 0″ below the bottom of the flooring joists, which are supported on this cross wall. The piers of the instrument and of the collimators are thus insulated from each other. Perhaps in such a soil as ours, fine building sand, as was said, this is the best disposition; but at any rate it was necessitated by the nature of the case. The *foundations* were thus brought to a level surface 11″ below the floor, and on these the piers were constructed from the plans furnished by the Messrs. REPSOLD.

Each collimator foundation contains 3,072 brick; the bricks weigh 4.48 pounds; and thus each collimator pier foundation weighs 13,760 pounds or nearly seven tons.

The foundations for the two collimators, and the single foundation of the two piers of the instrument having been brought to one level, the tops of these foundations were coated with a thin layer of plaster of Paris, and on this layer an accurate plan of the base of each of the four piers was drawn. The meridian and the prime vertical were also accurately laid down. Over the foundations a firm scaffolding was erected and frames for each of the piers were built; and the brick work was made to fit these frames. The piers themselves were built of hard, selected red brick, taken from near the arch of the kiln. Only Portland cement was used in their construction. All joints were broken, and every fifth course was a heading course. In each course, each brick of either of the two collimator piers or of the two instrument piers, has another brick in the corresponding collimator or instrument pier, symmetrically situated with respect to the meridian and the prime vertical. This applies even to the pieces which are less than the dimensions of a whole brick. That is, if you select any particular brick, either whole or cut, in any course of the north collimator pier, whose center is a inches north and b inches east of the center of the mercury basin, you can find another brick or part of a brick, of the same size as the first, in the south collimator pier, whose center is a inches south and b inches west of the center of the mercury basin. It was found to be quite as easy to build in this way as in any other. The piers of the instrument are similarly laid. The dimensions of the piers are as follows:

The piers for the instrument are 59.06 inches high (above the floor); those for the collimators are 66.73 inches. The dimensions of the piers of the instrument, on top, are 19.69 inches square. Eleven inches below the floor they are 33.07 inches square. The collimator piers on top are 31.89 inches (north and south) by 15.75 inches (east and west). Eleven inches below the floor they are 33.86 inches (north and south) by 33.07 inches (east and west). The distance from the center of the circle piers to the nearest faces of the two collimator piers is 70.87 inches. Each pier has a wooden casing made of alternate strips of white pine and black-walnut about $\frac{3}{4}$ inch thick. Each case is made in four sections, screwed together at the angles, and confined at the top by a cornice of walnut. At the bottom each section is screwed to a batten fastened to the floor. The inside of these cases is lined with tarred paper tacked to each section. Each instrument pier was covered with double face canton flannel confined round the top by thin wooden strips and cut in four pieces hanging loosely down each face of each (instrument) pier. Each of the four piers was also protected from change of air by a strip of flannel several times doubled, one edge of the strip being tacked to the floor, the other edge lying loosely against the bottom course of bricks.

These precautions enable us to preserve a layer of the best non-conductor, unchanged about the surfaces of the piers. To show how efficient this simple plan is, I cite the following experiment: I had a mass of smoke-producing material put in an open pan in the cellar below the piers for the instrument and lighted. Volumes of smoke were produced and maintained. These would instantly rush up through any opening made in the floor itself, but $2\frac{1}{2}$ minutes was required for the slightest sign of smoke to manifest itself in the open space between the top of the piers and the cornice of the wood cases. Practically we may say we have a constant layer of air confined about these piers. After some six months trial it was found that the collimator piers (which were not *wrapped* in flannel) were much drier, and that their wooden cases had warped less than those for the instrument; and the cause of this was believed to be that the

flannel absorbed and retained the moisture of the air in the cellar. The flannel *wrapping* was removed (December 1882) and additional folds of it were tacked to the flooring joists around each of the instrument piers, so that the loose ends of the flannel rested against the bases of the piers.

THE OBJECT GLASS AND ITS CELL.

The objective is by A. CLARK & SONS. Its clear aperture is 4.80 inches — 122 millimeters. Its focus is about 57.6 inches. The *inner cell* which holds the objective, is held to the *outer cell* which goes into the objective-end by 3 screws. Two steel springs push a loose block of the outer cell towards a bearing surface opposite. If the springs alter their tension with changes of temperature the change in collimation will be in *declination* only. The Nadir Point and not the collimation constant will be affected. In fact the Nadir-Point does change with changes of temperature. Two screws are provided which screw into the object-end and serve to handle it by. When they are removed the cap will cover the cell.

The two cells (inner and outer) above described fit into what I have called the object end. This is fastened by 3 screws to the face-plate of the tube, and it is interchangeable (in five minutes) with the eye-end.

ARC FOR SETTING THE CIRCLE.

Following the example of Professor ROGERS of the Harvard College Observatory, I have had a wooden arc 34.7 inches long, 3.6 wide, screwed flat against the wooden casing of the east pier. The radius of the arc is about 60 inches, and it is to be read by a long pointer (counter-weighted.) The arc itself is made of three thicknesses of veneer, to prevent warping; the two outer ones are of seasoned maple, the middle one of curled French walnut.

MICROSCOPES.

There are 8 microscopes, 4 for each pier. They have been numbered I, II, III .... VIII *here*, since it is necessary to distinguish them. The microscopes are 23.5 inches long. They are made of iron, with brass micrometers. They are held to the bearer by two iron clamps, one at each end. The clamp

nearest the objective can be loosened from the microscope; the other not easily. The former has 3 opposing screws (2 and 1), by means of which the adjustments are made, when the (single) screw of the eye-end-clamp is loosened. The focus of the objective can be changed; and by means of two opposing screws in the iron tube the microscope objective can be moved across the tube, so as to bring the image of the division to the cross wires. Thus the microscopes are very easily set just 90° apart. The objective is covered from dust by a little sliding cap. The micrometer can be rotated, and after rotation it can be fixed in position. The steadiness of the microscopes can be seen in the table of microscope distances at the end of this paper. The microscopes magnify 36 diameters. The probable error of a single setting is ±0″.16. The micrometer head is divided into 60 parts. One part =1″. The screws have ten threads to each 2.05 millimeters. The head is *numbered* at every 5th part, thus 20, 25, 30, 35, etc. This plan is certainly not a good one. The numbering should be at every 10th division. I have covered every 5th number with a small square of black paint. The field of view of the microscope covers about 49′ on the circle. It contains one fixed wire to mark the center of the field, and two *pairs* of moveable wires AA′ and BB′ perpendicular to the fixed wire. The distances AA′ and BB′ are about 30″. The width of a division is about 11″. The middle of AA′ is 90″(=1½ revolutions) from the middle of BB′. A comb scale of five teeth counts the whole revolutions. Ten revolutions is the middle tooth, and 12, 11, 10, 9 and 8 revolutions are marked. The pair of wires *nearest* the divided head is alone used in our practice.

By this arrangement of the wires, first suggested by MARTH, (*Ast. Nach.*, 1262 q. v.,) the errors which return once in a revolution can be eliminated in a simple manner. The pair of wires A is to be brought successively over two circle-divisions to the *right* (say) of the Zero of the comb scale, and the pair B successively over the two divisions to the *left*.

An examination of the microscopes V and VI showed that the periodic error was quite below the accidental errors of

reading. The other microscopes have not yet been investigated.

The 8 microscopes are marked I ..... VIII. When the circle is east microscopes I ..... IV are employed and the reading of the circle *increases* from I to IV.

I is the lower northern microscope;
II is " " southern " ;
III is " upper " " ;
IV is " " northern " ;

For circle west: the reading *increases* from V to VIII;—

V is the lower southern microscope;
VI " " " northern " ;
VII " " upper " " ;
VIII " " " southern " ;

In both positions of the circle the following scheme gives the divisions under each microscope.

Setting / Microscope.	I. / V.	II. / VI.	III. / VII.	IV. / VIII.
Z	Z—44°	Z+46°	Z+136°	Z+226°

Circle East; The south stars have the greatest reading;

Circle West; The south stars have the least reading.

ADJUSTMENT OF THE MICROSCOPES.

I. The microscopes should be 90° apart. This is effected by moving the clamps holding the eye and object end of each.

II. Two revolutions of their heads should be 120″. This is effected by moving the eye-end out or in, and focusing on the circle; at the same time moving the objective.

III. The line joining the zeros of each pair of microscopes should pass through the axis of the meridian circle and the plane containing the line and axis should contain the optical axis of the microscope. This can be tested by moving the

axis bodily east and west, and the REPSOLDS have provided a slow motion screw which moves the end (contact) levers which abut on the ends of the pivots. When the circle is east, loosen the clamping screws to both the contact-levers, and move the slow-motion screw of the east one. If the adjustment is not correct, a parallax is produced which must be eliminated.

ILLUMINATION OF THE MICROSCOPES.

This is the best I have ever seen; and the only illumination which can be said to be perfectly satisfactory. The beams from the lamps fall on four mirrors (adjustable) symmetrically disposed about the axis of the instrument on the frame of the microscope bearers.

These mirrors throw beams upon four other mirrors, one fastened to each microscope. Each of these latter mirrors throws its beam along the axis of its microscope on the graduated limb. The beam from the lamp opposite to that which lights the microscopes, goes directly into the axis of the circle to light the field of view. A part of the beam from the lamp illuminating the microscopes is reflected down by two fixed reflectors to illuminate the field of view of the setting microscope, and it *directly* illuminates the *heads* of the micrometers, thereby saving all the annoyance of hand lamps. This illumination is so simple and so good that it should take the place of every other.

It should be mentioned that the shadow of the bolt let in each brick pier and of the nut (on this bolt) which fastens the pier-head to the pier, is *necessarily* thrown on the mirror for illuminating the setting microscope. If a hole had been countersunk in the plate below the nut, the quantity of light available would have been greater. I have remedied this difficulty by sawing off part of the bolt and by covering one of the metallic mirrors with a piece of looking-glass.

SETTING MICROSCOPE.

This rests in Ys which are fixed to the east or west pier-head, and the microscope is shifted according as the circle is east or west.

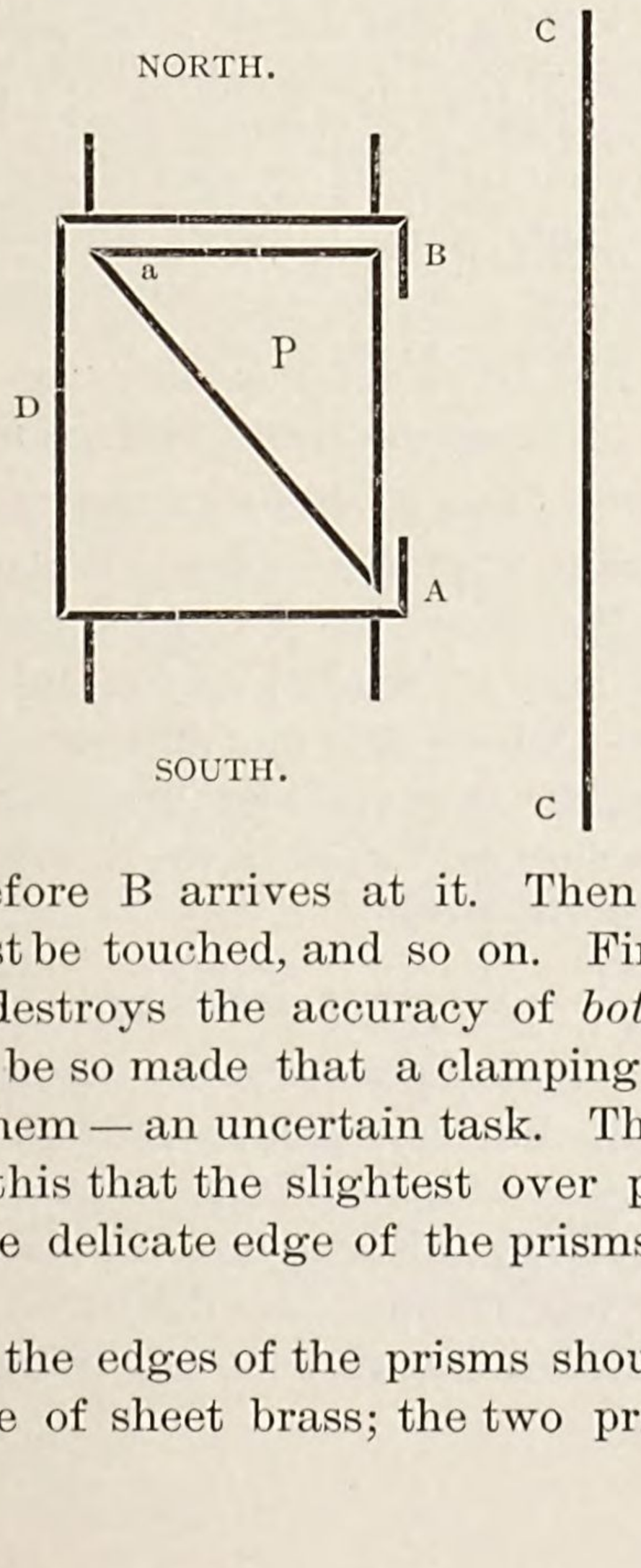
It has two prisms in its center that reflect the rays moving east (say) from the limb towards the north *and* south, and the two eyepieces view the limb. The field of view is 2° 10′, and as *every* degree is numbered, two degree numbers are always visible, and hence one is sure of the direction of increasing graduation, and can read between two marks. The illumination is perfectly simple in principle, and in practice it has been made satisfactory, as just explained, by replacing one of the metallic mirrors by a silvered glass reflector.

When the circle arrived I did not take the setting microscope apart, but by a slight adjustment I fixed the setting microscope prisms so as to make the reading the same when the observer was looking north or south. Since July 1st Mr. TATLOCK has used the north end of the setting microscope exclusively, so that it was not until December, 1883, that I discovered that the two settings were several minutes different, and was led to take the microscope apart, and to discover what seem to me radical defects in its design. As these are important, I will briefly indicate them. The two tubes of the north and south halves of the setting microscope end in a cubical box of brass, which contains the two prisms which reflect the light from the limb of the circle towards the north and south. Each prism rests at one end (which I shall call the pivot end) on a little strip of tin-foil; at the other end it rests on the point of a small brass screw (the adjusting screw). The head of this screw can be reached from the outside of the cubical box. Moving it in rotates the prism about its pivot edge. Both prisms are pressed down upon the adjusting screws and the tin-foils by a piece of sheet brass bent in the form of a V, which is put in the cubical box at the part furthest from the circle. The point of the V rests upon the back of the box (which can be removed); the legs of the V rest on the points of the prisms. The two prisms have their sides ground and move with considerable friction on each other. A set-screw through the top of the cubical box clamps the top prism upon the bottom prism, and the latter against the bottom of the box.

In the figure B is the adjusting-screw, A is the pivot-end, P is one prism, CC is the circle-limb, and D is the back of

the box. The V-shaped spring has the point of the V against the middle of D, and one leg rests on *a*.

To use the adjusting-screws on the outside, you must loosen the set screw; the prisms will now slide upon each other, but not freely, since their adjacent surfaces are ground. A movement of the adjusting-screw is opposed by the very unsatisfactory spring. Withdrawing the screw *should* produce a motion of the prism, but usually does not. Suppose that one prism A is adjusted and the other B is out. The process of adjusting B is this. The set-screw is loosened. The adjusting-screw of B is moved a little way. If the motion of B is in the right direction then one is fortunate and goes on. One observer must watch A, while the other adjusts B and watches it. Usually A is moved from the cor-



rect reading before B arrives at it. Then the adjusting-screw of A must be touched, and so on. Finally, clamping the set screw destroys the accuracy of *both* adjustments; which have to be so made that a clamping of this screw will complete them — an uncertain task. These are real defects. Add to this that the slightest over pressure on the screws chips the delicate edge of the prisms, as I found to my cost.

In any event the edges of the prisms should be protected by a small shoe of sheet brass; the two prisms should be

separated by a thin diaphragm of sheet brass fixed to the sides of the cubical box; and each should have its own set screw. If this is not done, then every circle should have an extra setting microscope to be used in case the regular one is out of order, as it is sure to be at sometime.

In our circle, I have had a small brass shoe put on the edge of the prism at the point where the adjusting screw presses. The tin foils at the pivot ends have been replaced by brass plates of the same thickness as the shoes. The north eye-piece of the setting microscope (circle east) has been replaced by a cheap filar micrometer with one moveable wire. We can now adjust the setting-microscope readily as follows: First, prism A is moved until the image of the required circle division falls on the fixed wire of eye-piece A; and then the movable wire of eye-piece B is placed on the image of the same circle-division, whenever it may happen to fall in the field of view. Finally, the single spider lines of the two eye-pieces have been replaced by thin plates of mica, whose blackened edges make a much better fiducial line than the faint spider thread. The setting microscope, with these changes, leaves nothing to be desired.

STEPS FOR READING THE MICROSCOPES.

At my request the Messrs. REPSOLD sent me the drawings of steps for reading the microscopes. It is not necessary to give the dimensions here, but I wish to say that these are very convenient, both for reading all four microscopes, or for zone observations, where only one microscope is read.

I have carpeted the steps and seat throughout. This makes the footing more sure, and absorbs the dust instead of allowing it to get upon the circle.

ARTIFICIAL HORIZON.

This is excellently and conveniently made on the plan described by BESSEL, in *Abhandlungen*, vol. ii, page 63.

All draughts and dampness from beneath the floor are completely avoided by this means. We use a joint of common tin furnace pipe (12 inches in diameter), over the basin during Nadir observations to keep off draughts from above the floor.

ILLUMINATING LAMPS.

Two excellent Argand lamps in convenient tin cases were provided by the REPSOLDS. I have mounted them nine feet ten inches from the center of the cube. I have also provided two gas burners which can be exchanged for the lamps in about one minute. Over each lamp, and also over a free gas burner for illuminating the room, I have put a 3-inch rain conductor which goes through the ceiling, and which delivers the heat from the lamps out of doors (not through the slit.) These tubes end just above the lamps in inverted funnels, 12 inches in diameter.

VENTILATION OF ROOM.

The air space above the flat ceiling of the meridian room is covered on the sides of the slit by wire netting, so as to allow of a free circulation of air, and it communicates with the external air when the shutters are closed, by 43 holes each three inches in diameter, which I have put in the cornice. The temperature of the room and of the air space is kept the same by this simple means. Before it was adopted the air space was extremely hot in summer days. The following table will exhibit the improvement.

Date 1883.	Time.	External thermometer.	Thermometer just above the circle.	Thermometer in air space.	Remarks.
August 7	22h 30m	70°.5	71°.0	72°.0	Slit opened at 22h 20m.
16	3 0	77 .5	74 .0	80 .0	
18	3 0	81 .0	82 .0	84 .0	
28	3 50	67 .0	72 .0	———	
Sept. 1	0 30	76 .0	77 .8	78 .5	Room entirely closed.
15	2 50	79 .5	76 .4	81 .0	
19	22 10	60 .5	62 .8	65 .5	Room opened at 20h 45m
27	3 0	61 .0	62 .0	63 .8	
Oct. 18	3 40	61 .0	62 .8	64 .0	

It appears that the difference of temperature between the air-space and the room, which was formerly 10°—15° in hot weather, has been reduced to 4° or so, by the simple device of boring the 3-inch holes.

REMARKS ON THE USES TO WHICH THIS CIRCLE IS FITTED.

A meridian circle of this class is especially fitted for doing fundamental work. The telescope is large enough to show 9th magnitude stars in a bright field, and the whole design of the circle is of the very best. For such work the whole circle must be investigated thoroughly; and it is especially important that frequent recourse should be had to nadir observations. In fact, we now have a model of the way in which fundamental observations with a meridian circle should be conducted in the volumes of the LEYDEN observations.

A very important research of this nature which seems to be obligatory upon every astronomer who possesses a first-class meridian circle is a thorough determination of his latitude. A list of stars selected from AUWERS' Fundamental Catalogue is now under observation here for this purpose.

The meridian circle of the Washburn Observatory is somewhat unfortunately situated as regards work in the northern regions of the sky. The site of the house is the nearly level top of a hill. To the west and east the ground slopes gently. To the south it is about level for some thirty feet, and then it descends about 40 feet in going southwards about 300 feet. After this plane is reached, the ground is nearly level for about eight miles, when a range of hills is reached, which are somewhat higher than the observatory hill.

The contour of the site towards the south makes it well nigh impossible to establish a (near) meridian mark. Towards the north along the meridian the ground slopes at first gradually and then rapidly to Lake Mendota; 100 feet north of the meridian circle the surface of the ground is 17 feet below the floor; and it slopes very quickly from this point as the following table will show:

Feet north of piers.....	100	200	300	400	500	600	700
Surface below floor.....	17	30	47	62	77	90	107

At 700 feet horizontal from the piers the shore of Lake Mendota is reached, and then we have towards the north a

level sheet of water about four miles wide. The opposite shore is a bluff some 50 feet high.

Stars culminating north of the Zenith must then be observed through air which lies over the lake, while stars south of the Zenith are observed through air which lies over land. The refraction for low circumpolars and for extreme south stars may be different. The lake is usually frozen from about December 5 to April 15 of each year, and the surface is covered with snow from three inches to three feet deep. During this period then, the relations of the surface of the ground to the superincumbent air are the same north and south, and *a priori* this season would seem to be the period for the accurate determination of the latitude. In the summer, it is possible that it will be necessary to determine two different co-efficients of refraction. One will serve for observations of north stars and the other for south stars. A list of refraction-stars is now under observation. Provided that the nadir can be continuously observed, it would seem that by suitably choosing the seasons of observation, fundamental work is practicable. Observations of the sun, however, would require a very careful treatment, since the winter and summer conditions are so different.

Unless strictly fundamental work is to be done it appears to be proper to do strictly differential work. The present admirable star list of the *Berliner Jahrbuch* makes this easy and accurate. For the present at least, all observations will be referred to the system of the B. J. in both co-ordinates. Those values of the flexure, of the refraction and of the latitude which best represent the normal system will be adopted and consistently used.

Investigations of the flexure, of the corrections to the Pulkova refractions to fit them to our conditions, and to the assumed latitude are now in progress. A list of miscellaneous stars for observation has also been selected.

VIBRATIONS OF THE SOIL.

From the pains taken with the piers I had hoped to find their stability perfect; and so far as the piers themselves are concerned I have every reason to be satisfied with them. I

have found, however, that the piers and foundations together are extraordinarily sensitive to vibrations in the surrounding ground, which is composed of fine building sand. I tested this thoroughly January 11, 1883, by having an assistant produce shocks in various places and by noticing the effects of these on the regular mercurial horizon, or on boxes of mercury placed on the piers of the instrument and collimators.

A person walking about on the floor of the transit room will just produce a slight tremor in the horizon. A strong blow with the foot anywhere on the floor of the room or of the adjacent hall will show itself in the mercury by a quick tremor. I satisfied myself in the most positive way Jan. 12 that such shocks were *not* communicated through the floor and to the wooden cases of the piers and thus to the horizon, but that they were transmitted downwards through the floor beams and to the brick supporting walls and thence through the fine, dry and unfrozen sand to the piers and to the horizon. Finally I had an assistant strike the ground with the end of a heavy 4x4 timber some 7 feet long, and such shocks were manifest in the mercury even when the blow was given fifty feet away from the piers and quite outside of the building. It was transmitted through the frozen sand. Such a shock fifty feet outside of the buildings seemed to be nearly as perceptible as one made within two or three feet of the walls.

On several occasions when I had the level (1 div. = 1.″2) suspended from the telescope for the purpose of determining the value of a division (not resting on the pivots) the bubble has suddenly begun to move north and south with an approximately periodic motion. The swings have occupied from ^{s} to $1^{m}\ 30^{s}$ for a half oscillation and the amplitude has ranged from 0″ to 13.″ I attribute this to the movements communicated to the hill by the ice in the adjacent lake, which is here four miles wide.

As far as I can determine these effects are very transitory and the result on the observations will be that the accidental errors will be increased perhaps largely. I do not now see

that any serious sources of constant error exist in this direction.

I add the instructions sent by the REPSOLDS to us:

"REMARKS RELATING TO THE PLACING OF THE MERIDIAN-CIRCLE.

"After the iron pier-heads are placed upon the piers, (of which a drawing has been furnished) all the correction-screws are to be put in the middle of their play; and then the base plates, with the pier-heads (microscope-bearers) are to be placed approximately in their correct position, without the use of the screws.

To help in this process there is packed in one of the boxes a wooden axis whose length and the dimensions of whose ends correspond with those of the axis of the instrument. By placing this wooden axis in the pivots, and by applying the hanging-level, it is easy to assure oneself of the correct level of the pier-heads, and of their proper distance apart. This distance must be the same as that of the feet of the level. If a diopter (or what is the same thing — a small telescope, provided with cross hairs) is fastened on to the middle of the wooden axis, it will be easy to see by means of a distant meridian mark, whether the axis is sufficiently near to the meridian. Also, the small arm, which is fastened to the end of the wooden axis will show whether the faces of the microscope bearers are placed parallel to the meridian. This can be tested by rotating the wooden axis in the pivots.

After these preliminary corrections are made, the base-plates can be fixed to the tops of the (brick) piers, with cement, or with plaster of Paris: and in the same way the large screws which fit into the cylindrical holes in the tops of the piers, can be fastened. The reversing-carriage is already adjusted to receive the axis, as soon as the large screw is inserted, and as soon as the movable bearer is fixed to this. The wooden stand must not be taken to pieces; it is only necessary to unscrew the iron tube with the worm-nut, and the large bevel-gear from the spindle, and to again screw both these parts together after the spindle is passed through the upper bearing. Before the rails (for the reversing-carriage) are fastened to the floor, the spindle must be placed vertical, by means of a try-level, fastened to the movable arm of the spindle, and at the same time the spindle is to be placed midway between the microscope-bearers. Then, the places of the rails can be marked down on the floor. After this the axis of the instrument (just as it is in the boxes) can be placed on the reversing carriage, for the purpose of fitting the circles, the object-glass, the ocular, etc. As soon as the large levers, which hold the hooks which take hold of the axis, are fitted with the counter poises, and with the hooks themselves, the axis can be placed in the Ys. At this place one must be sure that only one of the small levers which serve as end-supports of the axis, has its adjusting-screw set up, while the clamp on the screw of the other lever is left open, so that the inner pin of the screw may slide freely, and so that the lever can only be pushed forward by the motion of its thread. Otherwise, the axis will, as it moves on the wedge-shaped ends or the lever, have the

effect of bringing the tops of the piers nearer together. Moreover, one must observe whether the axis lifts perpendicular to the Y's, when the counter-weights are slightly over weighted: whether it touches only on one side of the Y's: and again, whether its ends are at unequal distances from the faces of the microscope-bearers. This last may be caused by the end-levers holding on too long. The first error may be corrected, when necessary, by turning slightly the four adjusting screws of the fulcrums of the levers of the counter-weights. For correction of the other faults, it may be necessary to ream out new bearings in the large lever (of the counter-weights) for the bearing-screws of the hooks which hold up the axis.

Care must also be taken that the slow motion in declination, after it is fastened to one of the movable iron arms, which are fixed to the two base-plates, is so fastened that the under movable part of the declination-arm comes in the middle of the screw that bears against the end. Under the hooks of the counter-weight are two eyes, into which the hooks at the ends of the two chains are to be slipped, whenever the instrument is to be reversed. The other ends of these chains are to be fixed to the wooden casings of the pier, and also the fair-leaders, which hold the upper parts of the chains nearly vertical. If the chains are made of the right length, they will hold on to the bar of the hooks, as soon as the axis is slightly lifted, and the pier will then always be charged with the same load.

The artificial horizon is to have its foundation so arranged on the base of the pier, that the under end of the ring, which is to be fixed in the floor, and which takes the cover, may enter the channel of the foundation, without touching it. By putting a little oil, or mercury, in this channel, the currents of air will be excluded, without the transmission of shocks from the floor to the piers. The two lamps are to be placed in the prolongation of the axis, at a distance of about two metres from the middle of the instrument. The wooden axis is hollow, in order to admit of their easy adjustment. Place this axis in the Ys, and place the lamps so that they shine through the axis. This is to be done without the two lenses and with the lamp doors wide open. The lenses are to be placed in such a position that they concentrate their beams upon the four mirrors. If the objective and ocular are interchanged, no change need be made in the illumination. The key which lies next to the telescope tube, changes the illumination from bright field to dark; the other changes the intensity of either mode."

TABLES OF THE INSTRUMENTAL CONSTANTS FROM JULY 8, TO DECEMBER 31, 1883.

The instrumental constants of the Circle and Collimators have been determined very frequently during the period, July 8th — December 31st, for the purpose of studying the Circle and piers. The observations have generally been made by Mr. TATLOCK. They have been projected into

curves and the study of these curves has led to our programme for the determination of the various constants and for the conduct of the observations. The curves are not given here, but the tables of constants are as follows:

TABLE I.

RECORD OF CONSTANTS, a; b; c; n.

DATE.	Time.	a.	b. nadir.	b. level.	c.	Remarks.
1883.	h m	s	s	s	s	
July 8	20–10		−0.455	−0.368	+0.013	The values marked with a star were determined by G. C. C. The epoch of his determination is uniformly about $8^h\ 30^m$.
*8	.....	+4.347	−0.343	−0.353	+0.077	
9	20–20	.....	−0.528	−0.447	+0.039	
10	21– 0	.....	−0.523	−0.495	+0.064	
11	20–30	.....	−0.442	−0.484	+0.116	
*11	.....	+4.51	−0.530	−0.553	+0.103	
12	20–30	.....	−0.429	−0.360	+0.034	
13	20–30	.....	−0.485	−0.436	+0.077	
14	21– 0	.....	−0.446	−0.380†	+0.047	† b level determined $19^h\ 30^m$.
*14	.....	+4.42	−0.444	−0.462	+0.086	
15	21– 0	.....	−0.519	−0.502	+0.069	
16	7–10	.....	−0.553	−0.493	+0.064	
16	20–45	.....	−0.498	−0.442	+0.039	
17	20–30	.....	−0.463	−0.455	+0.086	
*17	.....	+4.27	−0.445	−0.489	+0.084	
18	20–30	.....	−0.485	−0.517	+0.099	
19	20–30	.....	−0.549	−0.560	+0.099	
20	21– 0	.....	−0.588	−0.596	+0.116	
21	20–15	.....	−0.639	−0.665†	+0.111	† b level determined $19^h\ 30^m$.
*21	.....	+4.64	−0.636	−0.650	+0.098	
22	20–30	.....	−0.493	−0.480	+0.120	
23	20–45	.....	−0.403	−0.397	+0.116	
24	20–45	.....	−0.407	−0.401	+0.107	
*24	.....	+4.60	−0.345	−0.395	+0.129	
25	20–30	+4.595	−0.506	−0.495	+0.111	Epoch of $a=8^h\ 30^m$.
26	21–15	.....	−0.360	−0.383	+0.107	
27	21–30	+4.500	−0.339	−0.333	+0.098	Epoch of $a=8^h\ 30$.
28	21–40	.....	−0.335	−0.365	+0.120	
29	21–10	.....	−0.360	−0.368	+0.107	
30	20–50	+4.563	−0.386	−0.395	+0.116	
31	20–30	+4.570	−0.429	−0.435	+0.103	Epoch of $a=8^h\ 20^m$.
Aug. 1	22– 0	.....	−0.335	−0.328	+0.120	
3	4–30	+4.357	−0.345	−0.319	+0.086	Epoch of $a=8^h\ 10^m$.
4	2–45	.....	−0.352	−0.364	+0.120	
5	3–15	.....	−0.347	−0.326	+0.090	
	3–15	.....	−0.326	−0.296	+0.116	
	7–30	+4.367	−0.283	−0.330	+0.120	Epoch of $a=8^h\ 30^m$.
7	2–40	.....	−0.326	−0.313	+0.103	
8	3– 0	.....	−0.356	−0.351	+0.086	
9	3– 0	+4.344	−0.313	−0.307	+0.082	Epoch of $a=8^h\ 45^m$.
9	8–30	.....	.....	−0.333	.....	
10	4– 0	.....	−0.300	−0.264	+0.099	
11	3–30	.....	−0.395	−0.433	+0.107	
12	3–20	.....	−0.352	−0.357	+0.086	
13	3–30	+4.285	−0.244	−0.230	+0.103	Epoch of $a=8^h\ 30$.
13	8–30	.....	.....	−0.223	.....	

TABLE I — *Record of Constants* — continued.

DATE.	TIME.	*a.*	*b.* nadir.	*b.* level.	*c.*	REMARKS.
1883.	h. m.		s.	s.	s.	
Aug. 14	3–30	.....	—0.249	—0.274	+0.090	
15	3–30	.....	—0.244	—0.261	+0.099	
16	3–30	.....	—0.335	—0.341	+0.090	
17	3–30	.....	—0.390	—0.432	+0.094	
18	3–30	+4.504	—0.450	—0.472	+0.094	Epoch of a = 8h. 0m.
19	3–15	.....	—0.459	—0.467	+0.090	Higher power eye-piece put in collimator X to-day.
20	3–20	+4.340	—0.181	—0.236	[+0.030]	Evidently erroneous setting of same.
21	3–15	.....	.....	—0.312	.....	
21	7–15	+4.458	—0.322	—0.295	+0.073	Epoch of a = 7h. 50m.
			at 7h. 15m.			
22	3–0	.....	—0 073	—0.220	+0.094	Azimuth adjusted at 5h.
	3–30	.....	.....	—0.100	.....	
23	7–30	+0.033	—0.086	—0.076	+0.067	
24	3–10	.....	—0.073	—0.092	+0.082	*b* (nadir) at 7h. 20m.
25	4–15	.....	—0.112	—0.071	+0.069	*b* (nadir) at 7h. 10m.
26	4–0	+0.100	—0.086	—0.085	+0.060	Epoch of a = 7h. 45m.
*26	8–0	.....	.....	—0.058	.....	
27	3–0	.....	—0.086	—0.065	+0.069	
28	3–30	+0.135	—0.159	—0.159	+0.060	Epoch of a = 8h. 15m.
29	7–30	.....	—0.137	—0.134	+0.065	
30	3–45	+0.044	—0.137	—0.156	+0.069	Epoch of a = 7h. 15m.
*30	7–30	.....	.....	—0.149	.....	
31	4–0	.....	—0.287	—0.234	+0.064	
Sept. 1	4–0	+0.050	—0.240	—0.218	.....	Epoch of a = 8h. 15m.
*1	9–0	.....	.....	—0.208	.....	
2	3–0	.....	—0.209	—0.211	.....	
3	3–30	—0.106	—0.116	—0.114	+0.069	Epoch of a = 8h. 15m.
4	3–30	.....	—0.060	—0.075	.....	
5	3–30	.....	—0.039	—0.045	.....	
6	3–0	.....	—0.107	—0.122	.....	Changed focus of the telescope slightly.
7	3–0	.....	.....	—0.106	.....	
*8	8–0	.....	.....	—0.055	.....	
8	3–30	—0.342	.....	+0.007	+0.064	Epoch of a = 8h. 15m.
9	7–30	.....	—0.103	—0.149	.....	
10	7–30	.....	.. ....	—0.118	.....	
10	3–15	—0.288	.....	—0.116	.....	Epoch of a = 8h. 0m.
*11	7–30	.....	.....	—0.145	.....	
11	5–0	—0.249	—0.137	—0.146	.....	Epoch of a = 8h. 0m.
12	5–0	.....	—0.159	—0.183	.....	
13	3–30	.....	.....	—0.145	.....	Focus changed at 6h.
*14	11–40	.....	.....	—0.208	.....	Focus changed at 10h.
14	3–15	—0.085	.....	—0.212	.....	Epoch of a = 11h 30m.
15	3–15	.....	—0.279	—0.302	.....	At 10h changed setting of objective in its cell and adjusted focus.
16	3–0	.....	.....	—0.226	.....	
17	7–15	.....	.....	—0.048	.....	Adjusted.
17	3–30	—0.242	—0.086	—0.117	+0.047	Epoch of a = 7h. 50m.
17	23–30	.....	.....	—0.086	.....	
18	0–10	.....	.....	—0.089	+0.047	
18	8–0	.....	—0.043	—0.028	.....	Removed eye-end from tube for space of 5 minutes.
*18	0–30	.....	.....	.....	.....	

TABLE I — *Record of Constants* — continued.

Date.	Time.	a.	b. nadir.	b. level.	c.	n.	REMARKS.
1883	h. m.	s	s	s	s	s	
Sept. 19	3– 0	.....	—0.094	—0.067	... .	.....	Allowed sun
20	3– 0	.....	.....	—0.095	.....	.....	to shine on in-
21	8– 0	.....	.....	—0.112	.....	.....	strument 2m.
21	3– 0	—0.454	.....	—0.106	.....	.....	40s.; no effect
22	4– 0	.....	.....	—0.139	.....	.....	on any of the
23	5– 0	....	.....	—0.185	.....	.....	constants.
24	4–30	.....	—0.270	—0.168	—0.006	.....	
25	2– 0	—0.473	—0.206	—0.105	... .	.....	
25	8–15	.....	.....	—0.147	.....	.....	
26	5–30	.....	—0.107	—0.142	+0.099	... .	Epoch of a=
27	5– 0	—0.327	—0.123	—0.129	.....	+0.150	2h. 0m.
30	8– 0	—0.584	.....	—0.187	.....	.....	Epoch of n=
Oct. 1	9– 0	.....	.....	—0.209	+0.146	.....	7h. 30m.
2	5– 0	—0.585	—0.215	—0.188	+0.112	.....	
3	6–50	.....	—0.210	.....	.....	.....	
7	7–30	—0.420	.....	—0.276	.....	.....	
8	3– 0	.....	.....	.....	+0.090	.....	
10	5–10	.. ..	.....	—0.277	.....	....	
10	6–50	—0.352	.....	—0.261	.....	+0.097	
15	3–45	.....	.....	—0.191	.....	.....	
15	6–40	—0.761	.....	—0.181	.....	+0.429	
16	7– 0	—0.781	.....	—0.213	+0.090	+0.425	
18	3–30	.....	.....	—0.287	.....	.....	
18	8–40	—0.655	.....	—0.344	.....	.....	
23	3–30	.....	.....	—0.246	+0.082	.....	
23	8–40	—0.926	.....	—0.241	.....	.....	
25	8– 0	—0.725	.....	—0.296	.....	.....	
29	4– 0	.....	.....	—0.412	+0.073	.....	
29	10– 0	—0.559	.....	—0.417	.....	.....	
31	4– 0	.....	.....	—0.334	.....	.....	
31	7–40	—0.921	.....	.....	.....	+0.445	
Nov. 1	4– 0	....	.....	—0.245	.....	.....	
1	10–40	—1.072	.....	—0.278	.....	+0.605	
2	5– 0	.....	.....	—0.333	.....	.....	
2	10–30	—0.977	.....	—0.387	.....	+0.459	
3	5– 0	.....	.....	—0.408	.....	.....	
4	4–50	.. ....	.....	—0.426	.....	.....	
4	21–30	.....	.....	... .	+0.047	.....	
5	5–10	.....	.....	—0.531	.....	.....	Epoch of n=
6	4–40	—0.948	.....	—0.375	.....	+0.436	6h 15m.
7	4–40	.....	.....	—0.313	.....	.....	
8	4– 0	.....	.....	—0.321	.....	.....	
8	7–30	—0.893	.....	—0.358	.....	.....	
9	5–30	.....	.....	—0.382	.....	.....	
10	4– 0	.....	.....	—0.393	.....	.....	
10	9– 0	—0.761	.....	—0.348	.....	+0.317	
11	4– 0	....	.....	—0.279	.....	.....	
12	4– 0	.....	.....	—0.054	+0.073	.....	
13	5– 0	... .	.....	—0.214	.....	.....	
13	8–30	—1.704	.....	—0.287	.....	.....	
14	4–15	.....	.....	—0.110	.....	.....	
15	4– 0	.....	.....	—0.301	.....	.....	
15	7–15	—1.691	.....	—0.307	.....	.....	
16	7–30	.....	.....	—0.190	.....	.....	
17	0– 0	... .	.....	—0.312	.....	.....	
17	9– 0	—1.390	.....	—0.378	.....	+0.763	
18	4– 0	.....	.....	—0.429	.....	.....	

TABLE I.— *Record of Constants* — continued.

Date.	Time.	*a*.	*b* level.	*c*.	*n*.	Remarks.
1883.	h m	s	s	s	s	
Nov. 19	4- 0	.....	—0.467	.....	.....	
19	6- 0	—1.121	—0.509	.....	.....	
20	8- 0	.....	—0.509	+0.090	.....	
21	4-45	.....	—0.391	.....	.....	
22	4-45	.....	—0.355	.....	.....	
22	21-31	.....	.....	+0.060	.....	
23	4-30	.....	—0.391	.....	.....	
24	0- 0	.....	—0.472	.....	.....	
24	5-30	—0.892	—0.414	.....	.....	
25	4-15	.....	—0.551	.....	.....	
26	5- 0	.....	—0.251	+0.004	.....	
27	4-30	—1.213	—0.308	.....	.....	
28	4- 0	.....	—0.386	.....	.....	
29	1- 0	.....	—0.305	.....	.....	
30	4-15	.....	—0.470	.....	.....	
Dec. 1	4-15	—1.059	—0.574	.....	.....	
2	2- 0	.....	—0.474	.....	.....	
3	4-15	.....	—0.450	+0.004	.....	
4	4-30	—1.310	—0.457	.....	.....	
5	4-30	.....	—0.561	.....	.....	
8	4-30	—1.070	—0.335	.....	.....	
11	5-15	.....	—0.516	.....	.....	
11	4-30	—1.058	—0.483	—0.013	.....	
14	6-40	.....	—0.520	.....	+0.676	
18	9- 0	—2.370	+0.042	—0.047	.....	
20	9- 0	—1.762	+0.134	.....	.....	
24	7-20	.....	—0.672	.....	.....	
24	9- 0	—0.687	—0.682	—0.069	.....	
27	8- 0	.....	—0.446	.....	.....	
27	9- 0	—0.976	—0.411	.....	.....	
31	3-30	.....	—0.685	—0.064	.....	

TABLE II.

RECORD OF COLLIMATOR LEVELS.

Date.	Time.	Circle	Correction. N. C. X. 1396.	Correction. N. C. X. 1399.	Correction. S. C. Y. 1396.	Correction. S. C. Y. 1399.	Remarks.
1883.	h. m.		"	"	"	"	
July 9	22- 0	W.	—4.46	.....	.....	+6.29	N. C. = North Collimator.
10	22- 0	W.	—4.59	.....	.....	+6.73	
11	22-30	W.	—4.12	.....	.....	+6.56	S. C. = South Collimator.
12	22-15	W.	—3.92	.....	.....	+5.81	
13	21-45	W.	—4.10	.....	... .	+7.00	X and Y are the two collimators.
14	19-30	W.	—5.90	.....	.....	+6.55	
15	22-10	W.	—5.76	.....	.....	+6.49	
16	21-40	W.	—6.81	.....	.....	+6.61	
17	21-50	W.	—7.81	.....	.....	+6.84	
18	22- 0	W.	—6.68	.....	.....	+6.55	
19	21-45	W.	—6.54	.....	... .	+6.24	
20	22-30	W.	—5.97	.....	.....	+6.86	
21	19-30	W.	—5.74	.....	.....	+7.70	
22	20-40	W.	—5.78	.....	.....	+6.16	
23	20-50	W.	—5.82	.....	.....	+6.54	
24	21- 0	W.	—5.95	—6.45	+5.89	+5.93	
25	21-15	W.	—5.50	—5.94	+5.56	+6.25	
26	2- 0	W.	—6.46	—6.50	+6.64	+7.28	
26	3- 0	W.	.....	.....	+6.48	+7.08	
26	22-30	W.	—6.26	—6.58	+6.15	+6.63	
27	22-50	W.	—7.13	—7.22	+4.81	+5.42	
29	2-15	W.	—7.82	—7.82	+3.70	+4.93	
29	23-30	W.	—7.24	—8.08	+3.64	+4.54	
30	22-40	W.	—7.43	—7.60	+3.65	+4.26	
31	22- 0	W.	—7.16	—7.44	+4.18	+4.70	
Aug. 1	23-20	W.	—6.20	—6.93	+3.75	+3.68	
3	5-35	W.	—7.70	—8.31	+3.61	+4.02	
4	3-20	W.	—7.74	—8.13	+3.12	+3.23	
5	4-40	W.	—8.14	—8.71	+3.35	+3.83	
6	4-20	W.	—7.02	—7.54	+2.90	+2.91	
7	4- 0	W.	—7.80	—8.57	+3.88	+3.92	
8	4-30	W.	—8.33	—8.48	+4.30	+4.13	
9	4-15	W.	—8.57	—9.25	+4.08	+4.51	
10	5- 0	W.	—8.57	—8.99	+4.00	+4.34	
11	5-10	W.	—8.24	—8.73	+4.31	+4.57	Rain.
12	4-15	W.	—7.28	—6.95	+4.32	+4.67	
13	4-30	W.	—8.59	—9.59	+3.84	+4.36	
14	4-15	W.	—8.28	—8.84	+4.14	+4.02	
15	4- 0	W.	—8.13	—9.21	+2.21	+2.36	
16	4- 0	W.	—7.26	—8.57	+2.53	+2.23	
17	4- 0	W.	—7.21	—8.93	+3.15	+3.32	Rain, small amount.
18	3-45	W.	—7.83	—8.34	+2.91	+2.97	
19	3-30	W.	—7.64	—8.73	+3.69	+4.02	Rain, only a shower.
20	3-45	W.	—8.10	—7.86	+2.36	+1.73	
21	3-40	W.	—8.13	—9.63	+2.15	+3.54	
22	4- 0	W.	—8.18	—9.26	+3.21	+2.51	
23	4- 0	W.	—9.87	-10.29	—0.17	+0.86	3h. 30m. N. C. adjusted.
24	3-45	W.	.....	... .	+1.51	+1.13	
25	5- 0	W.	—1.43	—1.12	+1.61	+1.44	

TABLE II.— *Record of Collimator Levels* —continued.

Date.	Time.	Circle.	N. C. X. 1396	S. C. Y. 1396	Date.	Time.	Circle.	N. C. X. 1396	S. C. Y. 1396
1883	h. m.				1882	h. m.			
Aug. 26	3–30	W.	—1.″42	+0.″83	Sept. 30	5–15	W.	—4.98	+4.81
27	3–45	W.	—0.63	+0.45	Nov. 1	4–30	W.	—3.16	+3.74
28	5–0	W.	—0.50	+3.20	2	5–15	W.	—3.56	+3.93
29	4–45	W.	—0.09	+2.68	3	5–30	W.	—2.73	+4.81
35	3–30	W.	—1.07	+3.12	4	4–00	W.	—2.10	+4.46
31	5–20	W.	—0.71	+3.01	5	5–10	W.	—1.67	+4.59
Sept. 1	4– 0	W.	—0.24	+3.75	6	5– 0	W.	—1.84	+4.88
2	3– 0	W.	+0.01	+2.12	7	5– 0	W.	—2.13	+6.00
3	3-30	W.	+0.01	+3.03	8	5– 0	W.	—1.57	+6.01
4	3–15	W.	+1.48	+0.75	9	5–30	W.	—1.43	+4.38
5	3–30	W.	—2.41	+2.46	10	4– 0	W.	—2.10	+4.68
6	3–15	W.	—2.72	+3.20	11	5– 0	W.	—4.12	+5.26
7	3–15	W.	—1.61	+3.39	12	3–40	W.	—4.64	+4.72
8	3–15	W.	—2.80	+2.72	13	5–15	W.	—2.49	+6.00
9	7–30	W.	—3.03	+3.68	14	4–30	W.	—3.20	+4.85
10	3–30	W.	—1.44	+2.68	15	4–15	W.	—3.26	+4.33
11	5– 0	W.	—3.30	+2.80	16	8– 0	W.	—4.76	+8.24
12	5–30	W.	—2.37	+2.93	17	0–20	W.	—2.70	+7.67
13	3–30	W.	—2.13	+2.49	18	4–15	W.	—1.72	+6.02
14	3–30	W.	—1.39	+2.97	19	4–30	W.	—2.01	+5.31
15	3–30	W.	—0.76	+2.68	20	8– 0	W.	—2.08	—0.13
16	3–15	W.	—0.10	+2.88	21	5– 0	W.	—1.33	+0.77
17	3–15	W.	—1.82	+2.80	22	4–15	W.	—0.40	+1.79
18	3–15	W.	—2.23	+2.64	23	4–30	W.	—0.23	+3.19
19	3–15	W.	—0.76	+2.68	24	0–15	W.	—0.44	+2.09
20	3–15	W.	—1.54	+2.68	25	4–30	W.	+0.25	+1.66
21	3–15	W.	—1.15	+3.91	26	5– 0	W.	—0.95	—0.06
22	4–15	W.	—2.35	+3.64	27	5–30	W.	—0.41	+3.95
23	5–15	W.	—1.74	+3.03	28	4–30	W.	—1.11	+2.92
24	4– 0	W.	—0.89	+4.30	29	1– 0	W.	—0.28	+3.01
25	9–30	W.	—0.34	+3.20	30	4–30	W.	—0.71	+2.74
26	5–30	W.	—1.88	+4.04	Dec. 1	4–30	W.	—0.31	+2.71
27	5– 0	W.	—0.90	+3.81	2	2– 0	W.	—1.40	+1.56
28	5– 0	W.	—4.24	+3.29	11	5– 0	W.	+0.97	+2.85
29	5– 0	W.	—4.06	+3.87	18	4–30	W.	—5.46	+4.02

Dec. 25, both collimators adjusted; south end of both lowered.
31, N. coll. adjusted; south end lowered.

TABLE III.

RECORD OF NADIR POINTS.

Date.	Time.	Circle.	Nadir Point.
1883.	h. m.		
July 9	21–30	W.	125° 30′ 6″.17
10	21–40	W.	7.41
11	21–30	W.	7.53
12	21–30	W.	6.73
13	21–15	W.	6.24
14	21–30	W.	6.06
15	21–40	W.	6.73
16	21–20	W.	5.43
17	21–20	W.	5.20
18	21–20	W.	5.97
19	21–15	W.	6.36
20	21–40	W.	....
21	21–40	W.	6.66
22	21–20	W.	5.44
23	21–30	W.	5.00
24	21–30	W.	4.92
25	23–20	W.	5.47
26	21–20	W.	4.39
27	22–10	W.	3.43
28	22–15	W.	3.91
29	22–30	W.	3.22
30	21–30	W.	3.76
31	21– 0	W.	4.10
Aug. 1	22–25	W.	3.65
3	4–50	W.	3.89
4	3– 0	W.	4.55
5	3–50	W.	4.14
6	4– 0	W.	4.55
7	3– 0	W.	4.87
8	3– 0	W.	5.33
9	3–15	W.	10.51
10	4–30	W.	11.35
11	4–10	W.	11.76
12	3–45	W.	10.38
13	4–15	W.	10.43
15	4–20	W.	13.00
16	4–40	W.	11.52
17	4–10	W.	11.21
*18	4–30	W.	10.32
19	4– 0	W.	10.51
20	7–15	W.	10.13
21	7–15	W.	11.30
22	Adjusted azimuth at 5h.		
23	23– 0	Microscope adj'd.	
Aug. 24	7–30	W.	125°27′ 37″.28
25	7–30	W.	37.49
26	4–30	W.	37.04
27	7–45	W.	37.16
28	4– 0	W.	35.82
29	7–40	W.	35.50
30	5– 0	W.	35.57
31	7–40	W.	35.57
Sept. 1	5–30	W.	35.27
2	3–30	W.	33.31
3	7–15	W.	37.84
4	9–30	W.	35.07
5	4–15	W.	36.27
6	3–30	W.	36.34
6	8– 0	W.	35.96
7	4–15	Focus changed.	
8	12–08	W.	34.38
9	8– 0	W.	34.20
11	9– 0	W.	34.91
12	8–30	W.	35.45
12	23–45	W.	34.20
13	6– 0	Focus changed.	
14	10– 0	Focus changed.	
15	8– 0	W.	35.77
15	10– 0	Changed objective	
16	3–15	W.	34.07
17	5– 0	W.	35.36
18	9– 0	W.	34.98
19	9–30	W.	34.68
20	10– 0	W.	33.76
21	9– 0	W.	34.61
22	9–30	W.	33.49
24	8– 0	W.	31.04
25	0–15	W.	29.08
25	3– 0	W.	29.45
26	5–15	W.	31.25
26	8–15	W.	31.27
27	10– 0	W.	30.96
Oct. 2	5– 0	W.	30.94
3	4–45	W.	31.08
3	6–40	W.	31.08
10	4–15	W.	28.14
10	7–10	W.	28.42

*After August 17th, the microscopes were read both before and after the observations.

TABLE III, *Record of Nadir Points*—continued.

DATE.	Time.	Circle.	Nadir Point.	DATE.	Time.	Circle.	Nadir Point.
1883.	h m				h m.	W.	
Oct. 14	22–30	W.	125° 27′ 26″.22	Nov 23	21– 0	W.	125° 27′ 23″.76
15	4– 0	W.	26 .35	24	16– 3	W.	22 .22
15	7– 0	W.	26 .84	28	21– 0	W.	20 .91
15	23– 0	W.	25 .82	28	0– 3	W.	20 .67
16	1–30	W.	26 .03	28	0– 8	W.	21 .24
16	5– 0	W.	26 .86	30	21– 5	W.	22 .73
16	12– 0	W.	26 .59	Dec. 4	22– 3	W.	21 .94
	Sid. T.						
18	17– 7	W.	27 .66	4	0– 3	W.	22 .00
18	22– 2	W.	27 .87	4	2– 0	W.	22 .37
18	12– 7	W.	25 .83	4	13– 5	W.	22 .30
19	16– 2	W.	25 .73	5	23– 6	W.	22 .60
19	12– 5	W.	24 .44	5	0– 3	W.	22 .61
19	13– 8	W.	24 .62	5	2– 3	W.	23 .03
23	17– 7	W.	25 .13	8	0– 3	W.	25 .83
23	5– 1	W.	25 .73	8	2– 2	W.	24 .85
29	19– 0	W.	26 .02	10	0– 3	W.	22 .11
Nov. 1	18– 3	W.	21 .92	10	2– 2	W.	22 .92
1	21– 9	W.	22 .26	10	13– 5	W.	22 .34
1	12– 9	W.	23 .19	17	17– 5	W.	23 .10
3	20– 3	W.	24 .13	18	17– 4	W.	23 .96
4	20– 0	W.	25 .27	19	17– 3	W.	25 .86
5	19– 5	W.	25 .03	20	18– 1	W.	25 .71
6	19– 5	W.	22 .56	20	17– 4	W.	23 .62
8	19– 4	W.	24 .05	21	18– 2	W.	24 .87
9	20– 0	W.	23 .40	23	17– 5	W.	25 .75
10	20– 0	W.	21 .69	24	18– 4	W.	25 .65
17	20– 0	W.	24 .51	24	17– 6	W.	24 .17
18	20– 0	W.	25 .01	25	18– 5	W.	24 .54
19	20– 5	W.	25 .11	27	17– 9	W.	21 .48
21	20– 5	W.	23 .43	28	18– 8	W.	21 .62
22	21– 3	W.	23 .17				

RECORD OF MICROSCOPE DISTANCES.

Date, 1883.		Time.	V to VI. 90° +	VI to VII. 90° +	VII to VIII. 90° +
		h.			
July	31.....	21.0	5.″80	5.″90	5.″20
August	1.....	22.3	6.05	7.25	3.50
	3.....	4.9	6.70	5.65	4.60
	4.....	3.0	5.40	5.75	4.90
	5.....	3.9	6.20	5.10	6.00
	6.....	4.0	6.05	5.45	4.65
	7.....	3.1	6.40	6.75	4.25
	8.....	3.2	6.20	5.85	5.60
	9.....	3.4	7.15	6.10	3.95
	10.....	4.5	6.60	6.50	4.65
	11.....	4.2	6.55	7.50	3.45
	12.....	3.8	6.30	6.40	4.20
	13.....	3.5	7.25	6.80	3.10
	15.....	4.5	8.00	5.80	3.35
	16.....	4.7	6.85	6.55	3.85
	17.....	4.1	7.95	5.70	3.90
	18.....	4.3	6.28	6.03	4.68
	19.....	4.0	7.23	6.90	3.77
	20.....	7.2	7.30	6.45	2.57
	21.....	7.2	7.55	5.78	4.13
	22.....	Azimuth adjusted			
	24.....	7.4	— 4.10	5.98	0.55
	25.....	7.5	— 5.35	6.65	1.75
	26.....	4.4	— 5.40	7.75	1.30
	27.....	7.7	— 6.10	9.32	0.50
	28.....	4.0	— 6.20	9.50	0.10
	29.....	7.9	— 6.14	8.80	1.00
	30.....	5.0	— 6.20	8.20	1.40
		Changed focus of V.			
	31.....	7.7	— 9.90	10.20	2.05
September	1.....	5.5	— 7.50	10.65	1.70
	2.....	3.5	— 7.90	10.40	1.70
	3.....	7.2	— 6.60	9.95	0.50
	4.....	9.4	— 5.05	7.80	1.15
	5.....	4.0	— 4.40	7.37	0.35
	6.....	3.5	— 5.15	7.25	1.10
	7.....	Changed focus of tel.			
	8.....	11.5	— 8.00	7.70	0.90
	9.....	8.0	— 5.70	7.65	1.00
	10.....	No nadir this day.			
	11.....	9.0	— 6.80	7.50	2.15
	12.....	8.5	— 7.30	7.45	2.45
	12.....	23.8	— 7.30	7.80	2.75

RECORD OF MICROSCOPE DISTANCES.

Date, 1883.		Time.	V to VI.	VI to VII.	VII to VIII.
		h.	″	″	″
September	15	8.0	—6.65	+7.45	3.45
	16	3.3	—6.50	7.55	2.75
	17	5.0	—5.40	7.00	1.30
	18	9.0	—5.05	7.75	0.10
	19	9.4	—5.00	8.65	—0.60
	20	10.0	—5.90	7.90	+0.80
	21	9.0	—5.75	7.70	—0.15
	22	9.0	—8.05	9.65	+1.15
	24	8.0	—8.65	14.10	—0.05
	25	0.0	—10.00	12.85	+1.65
	26	8.0	—9.35	12.80	0.60
	27	10.0	—9.40	13.15	0.70
October	2	3.5	—9.55	11.75	2.00
	3	5.0	—8.95	11.10	+1.15
	10	7.0	—7.00	12.70	—1.50
	14	22.5	—9.05	11.20	—0.50
	15	4.0	—9.05	10.90	—0.30
	15	23.0	—8.95	9.75	—0.30
	16	1.5	—8.95	9.30	+0.80
	18	4.0	—6.90	8.95	+1.05
	18	9.0	—6.45	10.70	+1.00
	18	23.0	—12.95	16.75	—0.60
	19	22.5	—15.10	15.10	+0.30
		Sid. T.			
	23	1.5	—14.20	16.50	—1.75
	29	19.0	—12.85	16.05	—1.35
November	1	21.9	—13.75	13.95	—2.30
	3	20.3	—14.30	14.95	—1.65
	4	20.0	—14.55	15.50	—1.40
	5	19.5	—14.70	16.25	—1.45
	6	19.4	—13.80	15.80	—2.00
	8	19.4	—13.45	15.80	—3.15
	9	20.0	—12.80	15.70	—3.40
	10	20.0	—13.00	14.60	—2.70
	17	20.0	—14.20	13.25	—1.10
	18	20.0	—13.85	13.50	—1.75
	19	20.5	—13.90	14.70	—2.10
	21	20.5	—14.20	18.70	—6.40
	22	21.3	—13.99	18.70	—7.30
	23	21.0	—13.65	18.40	—6.95
	24	16.3	—14.00	18.10	—6.35
	28	0.3	—16.80	20.05	—7.85
	30	21.5	—14.75	18.10	—6.80
December	4	0.3	—14.40	16.50	—5.20
	4	13.5	—14.90	17.00	—5.55
	5	0.3	—15.10	16.90	—4.70
	8	2.2	—16.35	18.35	—5.85
	10	2.2	—14.25	18.15	—7.55
	17	19.5	—15.00	14.95	—6.90
	18	17.4	—13.90	13.00	—7.85
	19	17.3	—12.70	12.60	—8.70
	20	17.4	—12.75	12.65	—8.65
	23	17.5	—15.45	17.70	—5.80
	24	17.6	—14.80	17.85	—7.45
	27	17.9	—14.20	+15.95	—7.00

The — sign denotes that the distance is less than 90°. After October 23 the times are sidereal.

RECORD OF ERROR OF RUNS.

Date.	Time.	Errors.				Mean Error.	Proportional correction to 1″
		V.	VI.	VII.	VIII.		
1883	h m	″	″	″	″	″	″
July 8..	22–15	+0.67	+0.12	+0.81	—0.77	+0.208	—0.0016
11..	22–15	+0.61	+0.16	+0.85	—0.11	+0.377	—0.0020
12..	23–15	+0.23	—0.03	—0.45	—0.37	—0.155	+0.0009
14..	1–15	+0.67	+0.79	—0.11	—0.27	+0.270	—0.0015
16..	1–45	+0.89	+0.47	+0.42	—0.28	+0.375	—0.0021
17..	21–30	+0.37	+0.61	—0.71	—0.49	—0.055	+0.0003
18..	21–40	+0.77	+0.97	+0.13	—0.31	+0.392	—0.0022
20..	21–50	+1.09	+0.79	—0.29	—0.07	+0.380	—0.0021
22..	21–30	+0.71	+0.79	—0.19	—0.65	+0.165	—0.0009
24..	22–15	+0.61	+0.51	—0.27	—0.75	+0.003	0.0000
26..	21–40	+0.45	+0.49	—0.07	—0.51	+0.090	—0.0005
28..	22–45	+0.67	+0.63	—0.21	—0.59	+0.125	—0.0007
30..	21–45	+0.27	+0.29	+0.23	—0.57	+0.055	—0.0003
Aug. 3..	5–15	+0.21	+0.57	—0.71	—0.91	—0.212	+0.0012
5..	4–10	+0.61	+0.51	—0.11	—0.11	+0.225	—0.0012
8..	3–30	+0.85	0.00	—0.13	—0.23	+0.122	—0.0007
11..	4–35	+1.05	+0.91	—0.17	+0.25	+0.510	—0.0028
15..	5–15	+1.15	+0.27	+0.67	—0.41	+0.420	—0.0023
18..	5–0	+1.25	+1.13	+0.17	—0.39	+0.540	—0.0030
22..	4–40	+0.43	—0.77	—0.91	—0.77	—0.505	+0.0029
22..	23–0	Microscopes adjusted.					
23*.	5–0	+0.43	—0.73	—0.05	—0.41	—0.190	+0.0011
24..	5–8	+0.65	—0.61	—0.21	+0.39	+0.055	—0.0003
27..	8–20	+0.69	—0.53	0.00	+0.71	+0.218	—0.0013
31†.	4–30	+0.63	—0.25	—0.11	—0.51	—0.060	+0.0003
Sept. 1..	7–0	+0.67	—0.45	—0.71	—0.07	—0.140	+0.0008
5..	7–0	+0.35	—0.17	—0.59	—0.69	—0.270	+0.0015
10..	5–0	+0.35	—0.83	0.00	—0.65	—0.282	+0.0016
14..	4–0	+0.73	—0.63	—0.35	—0.81	—0.265	+0.0015
21..	3–45	+0.51	—0.55	—0.37	—0.67	—0.270	+0.0015
27..	5–30	+0.67	—0.41	—0.33	—0.11	—0.045	+0.0002
Oct. 4..	10–0	+0.05	—0.95	—0.99	—1.08	—0.742	+0.0041
12..	3–30	+0.39	—0.59	—0.75	—0.33	—0.320	+0.0018
18..	9–0	+0.29	—2.97	—0.75	—1.13	—1.140	+0.0063
19‡.	4–20	.....	—1.23	.....	.....	—0.705	+0.0039
23..	4–15	+0.19	—1.19	+0.11	—0.55	—0.360	+0.0020
29.	5–0	+0.11	—0.73	—0.11	—0.91	—0.410	+0.0022
Nov. 7..	21–30	+0.03	—1.07	—0.77	—0.65	—0.615	+0.0034
12..	5–0	+0.01	—0.68	—0.49	—0.53	—0.405	+0.0022
17..	5–30	+0.35	—0.75	—0.59	—0.41	—0.325	+0.0018
20..	23–0	+0.27	—1.91	—0.79	—0.41	—0.710	+0.0042
29..	0–0	+0.71	—1.37	—0.49	—0.49	—0.385	+0.0021
Dec. 6..	5–30	+0.49	—1.07	+0.11	+0.02	—0.112	+0.0006
24..	4–0	+0.23	—0.95	—0.33	—0.95	—0.500	+0.0028

* Microscopes adjusted anew at 23h.

† Changed focus of microscope V.

‡ Changed focus of VI.

From curves which have been constructed from the preceding tables we have the following general conclusions:

For certain periods (as Aug. 10–23, Sept. 20–29, Nov. 1–15, Nov. 20–27) the levels of the N. and S. collimators appear to change at the same time and in the same direction. For other periods (notably Sept. 3–7) they certainly do not change together. Hence any conclusions as to the connection of *both* these levels with the temperature or rainfall are extremely doubtful, at best. We might expect rainfall to affect the soil below the foundations of the collimator piers, (and those of the instrument in a far less degree) while the temperature will affect the adjustments of the steel screws which hold the Y's, etc.

I. From the curves it appears that the level of the North Collimator varies with the temperature directly.

II. The level of the South Collimator does not appear so to vary.

III. The effect of rain-fall on the levels is not certain, nor marked. In a general way it appears that rain causes the north end of each collimator to rise. One would naturally suppose that the N. end of the N. C. and the S. end of the S. C. would fall, after a rain.

IV. The azimuth of the instrument varies directly with the temperature. As the temperature falls the W. end of the axis moves north.

V. The level of the instrument varies inversely as the temperature. As the temperature falls the W. end of the axis is raised.

IV and V are very important deductions. They show that the thermometer must be read at the time of determining both a and b and at intervals through an observing night, and that values of these constants must be interpolated varying as the *temperature*.

VI. A change of temperature changes the zenith point, and for short periods the change of zenith point appears to be proportional to the change of temperature, sometimes directly, sometimes inversely. *A priori* we know that this change arises from two causes; first a change in the tension of the spring which confines the objective in its cell, and

second a change in the position of the microscopes on their frame. It is probable that the first cause hardly shows in the daily curves which have been constructed. The microscopes themselves move slightly under the effect of changes of temperature, but it appears to be a matter of chance whether this movement is such as to increase or diminish the zenith point reading.

III. — METHODS OF DETERMINING THE INSTRUMENTAL CONSTANTS.

COLLIMATION CONSTANT.

The collimation-constant is determined by means of the horizontal collimators.

The telescope is first pointed towards the south collimator and the movable pair of wires in this collimator is so placed as to occupy the space in the field of the telescope between the wires D_3 and D_4,* or between D_4 and D_5. The telescope is then placed vertical, and the caps which cover the aperture in the cube being removed, the observer, at the north collimator, superposes the moveable pair of wires in the north collimator upon the movable pair in the south collimator, in the following manner: The pair in the north collimator is moved until the space between them is bisected by the east wire of the pair in the south collimator, and the micrometer head is read off. The west wire of the pair in the south collimator is then made to bisect the same space and the micrometer is again read. The mean of the two readings in the reading of the micrometer when the two pairs are superposed. All bisections are made by moving the micrometer in the direction of increasing readings. Ten bisections are made on each wire and the micrometer is set at the mean of the readings. The telescope is then pointed to the south collimator and four bisections of the space between its movable pair of wires are made by the A. R. micrometer

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*For 1883 the spider line reticle was used. The process is similar for the glass reticle, which was inserted February 6, 1884. This reticle moves with the R. A. Micrometer-screw.

and the mean of the readings taken. The telescope is then pointed to the north collimator and the same process is repeated. The mean of the readings on the two collimators is the reading when the micrometer wire is in the line of collimation of the telescope.

Let

c = collimation for the middle wire, uncorrected for diurnal aberration, and

c_o = the same corrected,

M_s = reading of micrometer when the telescope is pointed to the south collimator.

M_n = reading of micrometer when the telescope is pointed to the north collimator.

M_o = reading for co-incidence of micrometer and middle wire,

R = 1 rev. of micrometer in seconds of time,

φ = latitude,

Then for *Circle West* or *Circle East*;

$$c_o = R\left[M_o - \frac{M_n + M_s}{2} \right] - 0^s.021 \cos \varphi;$$

$$= 4^s.295 \left(M_o - \tfrac{1}{2} \{ M_n + M_s \}\right) - 0^s.015.$$

If we set the glass reticle so that the R. A. micrometer reads $\frac{1}{2}(M_n + M_s)$ then $c = o$, and $c_o = -0^s.021 \cos \varphi$. The R. A. micrometer is set at $\frac{1}{2}(M_n + M_s)$ and clamped at this reading.

The collimation constant is usually determined once a week (Monday) the daily determinations detailed in the preceding tables having abundantly shown that the collimation remains constant for much longer periods. The probable error for a single setting has been found to be $\pm 0^s.010$, and of the concluded constant $0^s.003$.

LEVEL CONSTANT.

The level constant is determined in two ways, (*a*) by the hanging level and (*b*) by observations of the nadir.

(*a*) The level is placed upon the axis of the telescope, which is pointed to the zenith or nadir, with the level tube on the

south side, and the level read. It is then placed with tube to the north of the telescope and again read. This constitutes a complete observation. Three complete observations are taken. The level tube is graduated from end to end and numbered from 0 to 60. When the west end of the bubble has the largest reading the readings of both ends are marked +; in the contrary case —

The level constant is

$$b = \frac{\Sigma \text{ w} + \Sigma \text{ e.}}{12} \text{ D.}$$

In which D = 1 div. of the level = $0.^{s}083$.

$$\text{The p. e. of } \frac{\Sigma \text{ w} + \Sigma \text{ e}}{4} \text{ is } \pm 0.^{s}010.$$

Or of b, it is $\pm 0.^{s}006$ (from three reversals.)

(b) In the second method of determining b the telescope is pointed to the Nadir box, and with the collimating eye-piece the wires of the reticle and their reflected images are seen in the field at the same time. The distance between D^{4} (the mid-wire) and its image is then measured by means of the R. A. micrometer in the following manner: The micrometer wire is placed beyond the reflected image of the mid-wire in such a position that the distance between it and the reflected image of the mid-wire is equal to the distance between the mid-wire seen directly and by reflection. The mic. head is read off, and the micrometer wire is then placed beyond the mid-wire, so that the distance between it and the mid-wire seen directly is equal to the distance between the mid-wire seen directly and by reflection, and the mic. head is again read off. This operation is repeated five times.

Let

b = level constant.

c = collimation constant *uncorrected* for diurnal aberration.

M = micrometer reading when the wire is beyond reflected image of mid wire.

M^{1} = micrometer reading when the wire is beyond the mid wire seen directly.

R = value of 1 rev. of R. A. micrometer.

Then

$$b = \tfrac{1}{6}.\ \mathrm{R}.\ (\mathrm{M} - \mathrm{M}') + \mathrm{c}.$$
$$= 4^{s}.295.\ \tfrac{1}{6}\ (\mathrm{M} - \mathrm{M}') + \mathrm{c}.$$

The probable error of a single determination of b from each pair of measures of M and M′ by this method has been found to be $\pm 0^{s}.013$, assuming c to have been determined with a *p. e.* of $\pm 0^{s}.003$. Five pairs of measures of M — M′ give b with a *p. e.* of $0^{s}.006$, which is the same as *p. e.* of b determined by three reversals of the spirit level. The value of b varies *inversely* as the temperature, the coefficient being small, however. With the glass reticle let M_{o} be the reading of the R. A. micrometer when it is set for c = o. M′ be the reading of the R. A. micrometer when the middle thread O_{7} coincides with its reflected image, then

$$b = 4^{s}.295\ (\mathrm{M}' - \mathrm{M}_{o})\ \text{Circle W.}$$
$$b = 4^{s}.295\ (\mathrm{M}_{o} - \mathrm{M}')\ \text{Circle E.}$$

AZIMUTH CONSTANT.

As it has been found to be impracticable to erect a meridian mark for controlling the azimuth of the instrument, the azimuth constant is determined in the usual way by combining observations of polar and time stars, or by observation of a circumpolar star both N. C. and L. C.

The azimuth constant has been found to vary directly as the temperature, the coefficient being small, however.

NADIR–POINT.

To determine the zero of the circle by observations of the Nadir, the telescope is pointed vertically downwards and clamped. It is then moved by means of the slow motion in declination until the reflected image of the fixed pair of horizontal wires (seen by the collimating eyepiece and the illumination from a kerosene lamp shining through a screen of oiled silk) is at a distance of 8″ to 10″ north or south of the pair seen directly. The circle is then clamped and read, by its pointer and four microscopes. The observer then measures the distance between the horizontal wires and their reflected image in the following manner: The reflected

wires being south of the wires seen directly, the *single* movable Z. D. wire is placed *north* of the horizontal wires seen directly, so that the distance between it and the north horizontal wire is equal to the distance between the horizontal wires. The micrometer head is read off and the movable wire is then placed to the *south* of the reflected wires, observing the same conditions as to distance as in the former case. The distance, given by the difference of the two micrometer readings, is denoted by δ_1. The micrometer wire is then placed alternately to the *south* of the wires seen directly and to the *north* of the reflected wires, in the same relative position to them as before, and the resulting distance is denoted by δ_2. The apparent distance between the middle of the pair of wires seen directly and the middle of the pair seen reflected is

$$\Delta = \frac{\delta_1 + \delta_2}{2}$$

The correction to be applied to the circle reading, to obtain the Nadir-Point is $N = \pm R. \frac{1}{4} (\delta^1 + \delta^2)$,

where N = the correction in seconds of arc,
R = 1 rev. of micrometer-screw,
= 64″.527.

Use the *upper* sign when the reading for the reflected wire is *less* than the reading for the wires seen direct, and the *lower* sign when it is *greater*. The 4 microscopes are again read after the micrometric measures are concluded, and the mean of the two sets is taken as the circle reading to which N. is to be applied. From 108 cases it results that the *p. e.* of a single measure of δ_1 or δ_2 is ± 0.″19, and thus the *p. e.* of $\delta_1 + \delta_2$ is ± 0.″27. As the micrometer correction depends upon 4 measures of $\delta_1 + \delta_2$, its *p. e.* is ± 0.″14. The *p. e.* of the mean of 4 microscopes is 0.″06 (read twice), so that the *p. e.* of a concluded Nadir-Point is about 0.″15.

When the glass-reticle is employed the only spider lines in the micrometer box are those of the Z. D. micrometer, *viz.*: a pair of wires (wire A) and a single wire (wire B). Wire B is almost invariably employed in observation of stars and always in observing the nadir.

The sight line of the telescope is supposed to be defined in the field of view by the position of wire B when it is at 10.000 revolutions. To determine the nadir point the telescope is pointed to the nadir box and wire B is put in coincidence with its reflected image, four complete measures being made. Call the mean of these M. The correction to be applied to the circle reading to obtain the Nadir-Point is then (10.000—M) 64.″527 (circle W. and E.)

HORIZONTAL POINTS FROM LEVELLED COLLIMATORS.

From the series of levels made by Miss SANBORN to determine the inequality of the pivots of the two collimators, it follows that the mean value of the probable error of a single determination of p is $\pm 0.''16$. As p is derived from the difference of two levellings, each of the latter is affected by a $p.\ e.$ of $0.''11$ which may be taken as the $p.\ e.$ of the level-constant of a collimator. The two series from which this value is derived were made with extreme care, and it is not probable that this precision could be attained in a regular series of observations made at night. It represents rather the extreme limit of precision. The $p.\ e.$ of the mean of 4 pointings of the telescope micrometer on the collimators is $0.''05$, and the $p.\ e.$ of the mean of 4 microscopes is $0.''08$.

From these data it follows that the $p.\ e.$ of a horizontal point is $0.''15$; which is just the same as the $p.\ e.$ of a concluded nadir-point. The nadir-observation is to be greatly preferred to the observation of the levelled collimators on account of the greater convenience of the observation of the nadir, which can be equally well made in the day or in the night, while the collimators are more difficult to observe at night when they are required most.

EQUATOR-POINT.

To determine the equator-point of the circle in differential observations, the fundamental stars of the *Berliner Jahrbuch* are alone used. These are completely reduced, and each corrected circle-reading compared with the declination of the *Jahrbuch* gives one value of the equator-point.

From what has gone before it appears that the various processes relating to the determinations of declination are affected with probable errors as follows:

The probable error of a Nadir-Point (obtained by the programme previously described) is $\pm 0''.15$. This accidental error is to be further increased by the uncertainty due to the division-errors of the circle. The *p. e.* of the reading of a single microscope on a single division is $\pm 0''.16$. Supposing the circle to be perfectly divided and to retain its shape, the mean of 4 microscopes has a *p. e.* of $\pm 0''.08$.

The *p. e.* of an Equator-Point from a single fundamental star, with the microscopes read once has been found to be $\pm 0''.62$. This includes the effect of deviations of the standard declinations from those of a truly normal system.

From a preliminary discussion of the observations of certain stars which have been observed for latitude, for each of which the microscopes have been read twice at each observation, it follows that the *p. e.* of an Equator-Point from a single star with microscopes read twice may be reduced to $\pm 0''.53$.

In the ordinary practice of determining the Equator-Point the microscopes are read twice whenever this does not prevent the observation of some one of the stars whose declinations are required. We may fairly assume the *p. e.* of an Equator-Point from a single star to be $\pm 0''.60$.

Then we shall have the following table:

P. e. of an equator-point from 9 stars $\pm 0''.20$;
8 stars $\pm 0''.21$;
7 stars $\pm 0''.23$;
6 stars $\pm 0''.25$;
5 stars $\pm 0''.27$:

And the *p. e.* of a single declination depending on an equator-point derived

From 9 stars $\pm 0''.65$)
From 5 stars $\pm 0''.68$)

If a star is observed three times *Circle E.* and three times *Circle W.* (and if there is no systematic difference *Circle E.*

and *W.*) the *p. e.* of a concluded (catalogue) declination from six observations should be about 0″.3.

It can only be decided by trial whether this degree of precision can be realized. As the numbers above depend upon actual observations reduced with the Pulkova Refractions, and as it appears from our observations of Refraction Stars, that we may expect to satisfy the normal system of star-places better by a slightly changed refraction, it is to be hoped that the *p. e.* of a single declination will not be much above 0″.65. ARGELANDER (*Bonner Beob.* vi, S. xii) found for bright equatorial stars ±0″.60.

ERROR OF RUNS.

The correction for error of runs of the microscopes is determined by means of the divisions of the extra arc. The arc being brought into the field of one of the microscopes, five pointings with the microscope micrometer are made upon the division *b* and then five upon the division *a* whose distance from *b* is 179″.93.

Let B = the mean of the pointings on b.

A = " " " " " " a.

Δ = distance in seconds of arc between b and a.

E_I = *correction* for runs, for microscope I.

$E_I = \Delta - [180'' + (A - B)]$.

$= 179''.93 - [180'' + (A - B)]$.

E_{II}, E_{III} and E_{IV} are formed in the same way and

$$E = \frac{E_I + E_{II} + E_{III} + E_{IV}}{4}.$$

The proportional-correction to 1″ is $\frac{E}{180}$; and this quantity is to be multiplied by the number of seconds between the mean of the four microscopes and zero, and applied to the circle reading.

This process is the same *circle E* or *circle W.*

CORRECTION FOR INCLINATION OF THE MICROMETER-WIRE.

If a polar star is used to determine the inclination, it is bisected at several (sidereal) times t', t'', t''' by the micrometer which will read

$$M', M'', M'''.$$

Let t be the time of transit over the meridian of the instrument, and m an (assumed) micrometer reading corresponding to t, and dm the correction to m. Let μ be the reduction to the meridian. Then each observation gives an equation of the form, $m - M' = -dm - \mu - \cos\delta . \sin(t' - t)$ I. From all the bisections I is to be found; and the correction i'' for a star in the parallel δ is

$$i'' = I . \cos\delta . \sin 15 . t^s .$$

δ is the star's declination; $t = \tau - m$ (BESSEL'S m); τ is the hour angle counted towards the East, positive; I is the inclination, positive when with the telescope pointed to the south horizon, the east end of the horizontal thread is below the horizon.

THE FLEXURE CONSTANT.

To determine the flexure by the collimators they are turned in their Ys, so that their micrometer wires are horizontal and *near the middle of the field.* This precaution is important. The wires of the north (or south) collimator are superposed upon those of the other, in the same way as before described. Temperatures are read from thermometers in front of the objectives of the two collimators and over the circle and no series has been accepted when these three thermometers did not agree within four degrees *Fahr.* during the whole of the process. In order to obtain such constancy of temperature, special care has to be taken with the ventilation of the room. The actual *measures* are usually made with the shutters closed, but they usually have been open for some hours previous to the observation. Ten pointings of the N. C. on the S. C. are made and the micrometer is set to the mean of the readings. The *p. e.* of a single setting

(two measures) is ± 0″.15, and of the mean of the 10 it is ±0″.047. We may suppose half of this *p. e.* to belong to the N. C. and half to the S. C.

The telescope is then directed towards the S. C. and the micrometer zero determined. The *p. e.* of a single determination (two measures) is ±0″.069. Four settings are made; *p. e.* = ±0″.035. The circle is then clamped and the four microscopes read: *p. e.* = ±0″.08. The pair of horizontal wires in the S. C. is then bisected by the Z. D. micrometer wire, nine times. The *p. e.* of a single bisection is ±0″.096; of the mean of nine it is ±0″.032. The four microscopes are again read, and as their mean is combined with the mean of the preceding reading of the same four, the *p. e.* of the resulting correction to the circle-reading on account of microscopes is ±0″.057. As far as the telescope and microscopes are concerned we have the *p. e.* of the setting on the S. C. ±0″.074. We may allow 0″.024 as the *p. e.* of the position of the S. C. (that of the N. C. being assumed to be the same). Hence the *p. e.* of the whole operation of setting the telescope on one end of the line determined by the collimators may be taken as ±″0.078. The telescope is then turned through the zenith and set on the N. C. in precisely the same way; the operation involving the reading of four microscopes before and after, and making nine settings of the Z. D. micrometer on the wires of the N. C. The *p. e.* of the whole operation of setting the telescope on the other end of the line above described is ±0″.078.

The telescope is now unclamped, and the whole operation is repeated on the N. C. It is then turned through the nadir and set on the S. C. as before. In each case the *p. e.* of the whole operation of determining one end of an arc of 180° is ±0″.078. Therefore each arc of 180° is determined with a *p. e.* of ±0″.110, and the final value of the flexure from both arcs with a *p. e.* of ±0″.08. Hence if the flexure is not above 0″.2, the operation must be very carefully conducted in order to find any satisfactory results.

At the end of the series the reading of one collimator on the other is tested. In case the co-incidence changes, the series should be rejected. We have occasionally distributed a small change proportionally to the time.

Let the actual circle readings (with the micrometer correction applied) be

A for the first pointing on S. C.;
B for the first pointing on N. C.; } through zenith.

C for the second pointing on N. C.;
D for the second pointing on S. C.; } through nadir.

h = horizontal flexure.

Ordinarily B and C are identical.

$$\textit{Circle West} \begin{cases} 2\,h = 180^\circ + (B - A) \\ 2\,h = 180^\circ + (C - D) \end{cases}$$

$$\textit{Circle East} \begin{cases} 2\,h = 180^\circ + (A - B) \\ 2\,h = 180^\circ + (C - D) \end{cases}$$

As a matter of fact, the flexure will be determined in the course of a series of observations on two selected lists of B. J. stars, one the latitude-list, the other the refraction-list. It is intended to deduce from these stars such values of the refraction, the latitude and the flexure as will best satisfy AUWERS' fundamental system, and in future to make observations in both co-ordinates strictly differential with this system.

IV. — REDUCTION OF OBSERVATIONS IN RIGHT ASCENSION.

REDUCTION TO THE MIDDLE THREAD.

The telescope has two reticles. During 1883 the spider-line reticle was employed. Subsequently, the glass reticle will take its place. The equatorial intervals of both reticles have been previously given. It only remains to give the nomenclature of each.

THE SPIDER-LINE RETICLE.

This contains seven groups of wires:

$A_{1,2,3}$; $B_{1,2,3,4}$; $C_{1,2,3}$; $D_{1,2,3,4,5,6,7}$; $E_{1,2,3}$; $F_{1,2,3,4}$; $G_{1,2,3}$

In all twenty-seven wires. All observations are reduced to D_4. The wires retain their names, *Circle East* or *Circle West.* An equatorial star, *Circle W.*, crosses them in the order A....G. The revolutions of the R. A. micrometer increase in the direction G....A.

If F^s is the equatorial interval of a thread from the middle wire, a transit over that wire is reduced to the mid-wire by the formula $f^s = F^s \sec. \delta$ up to 82° north declination. For stars farther north the complete formula Sin. $15\,t = \sin. 15\ F^s \sec. \delta \sin. 1''$ is used. $f^s = 15\,t =$ the reduction for the parallel of the star. If the transits are registered by a mean time clock, for F^s in the above formulæ the quantity 0.99727 F^s must be substituted.

THE GLASS-RETICLE.

This contains 5 groups of wires; L_1; $M_{1,2,3}$; O (13 wires), $P_{1,2,3,}$ Q_1.

The central group O has 5 wires for its whole length, *viz.*: O_1, O_4, O_7, O_{10}, O_{13}. For half the length of the reticle (in Z. D) there are two wires, O_2, O_3, O_5, O_6, etc., ruled between each pair of long lines. The intervals of O_1, O_2, etc., for *Polaris* are about 30^s.

This whole reticle moves with the R. A. micrometer screw. L is nearest to the micrometer head. The wires always retain the same names. An equatorial star *circle west* crosses the wires in the order L ..... Q.

The reticle of our meridian circle is so arranged that a number of threads lie on either side of the central groups over which the right ascensions will be observed. In the usual practice the star is bisected *once* before the observation of R. A., and *once* after the observation. After the first bisection in Dec. is made, the observer has to take his chronograph-key and observe the transits, and then to lay down this key and to make the second bisection. It is taken for granted that no bisection will be recorded unless it is satisfactory. For example, if no satisfactory bisection can be made before the transits, the observer always knows that he has sufficient time after them, to make at least two bisections, and he can therefore be critical. The transits, how-

ever, must be taken over certain wires, and it is possible that the precision of these transit-observations may be influenced by the knowledge of the observer that he has one or more bisections to make after them. It is possible to observe the declination on two wires *after* the transit (case I); on two wires *before* the transit (case II); on one wire *before* and one wire *after* the transit (case III). The question is, is one of these three ways preferable to the two others? or does the right-ascension observation suffer in precision from either of these arrangements of the declination bisections?

The answer to this question should decide the method to be habitually adopted. Observations made specially to answer the question will not be so valuable as others made without reference to it. I have therefore chosen 60 observations made by observer F. with the Washington Transit Circle in 1872, in which instrument the wires are arranged similarly to our own. In 20 of these observations the transits over 9 wires were observed first and the declination was observed after the transits. (Case I.) In another 20 the declination was observed over two wires *before* the transits. (Case II.) In another 20, one bisection was made *before* and one *after* the transits. (Case III.)

The *average mean error* of a single transit over a single wire was for

	Case I.	Case II.	Case III.
E =	$0^s.028$.	$0^s.025$.	$0^s.025$.

It appears that the precision is practically the same in the three cases, and that there is no reason to prefer one method to another. To eliminate the inclination of the micrometer-thread, the method III will be habitually followed.

FORMULÆ.

The observations in R. A. are reduced by the following formula:

$$\text{R. A.} = T^m + (\Delta T + m) + n \tan \delta \begin{cases} + c \sec \delta - 0^s.021 \cos \varphi \sec \delta \\ + c' \sec \delta, \end{cases}$$

T^m = clock time of transit over the middle wire, corrected for the rate of the clock; ΔT = clock correction. For stars

L. C. substitute $180° - \delta$ for δ. With the glass-reticle c sec δ is made zero by adjustment.

The star places on which Δ T, m and n depend are taken from the list of the *Berliner Jahrbuch,* and all stars of this list, observed in the course of a night's work, are divided into two groups, designated as polar and time stars.

The polar group contains stars north of 65° north declination, the time stars are those south of this limit.

For the determination of $(\Delta T + m)$ and n, each known star observed gives an equation of the form

$$\text{R. A.} - T^m - c' \sec \delta = [\Delta T + m] + n \tan \delta.$$

$$\text{or R. A.} - T^m + 0^s.015 \sec \delta =$$

The mean of the equations resulting from the time stars is combined with the equation from each polar and the value of n is determined. The arithmetical mean of the individual values of n is generally adopted, and being substituted in the equation from the time stars, the value of $\Delta T + m$ is determined.

As a check, the value of n is substituted in each of the equation from the time stars and the individual values of $\Delta T + m$ computed. The mean of these values should agree with the value first determined.

For the determination of the clock correction Δ T, it is necessary to read the level once every hour and thus determine b. Then

$$m = b \sec \varphi - n \tan \varphi; \text{ and } \Delta T = (\Delta T + m) - m.$$

For an observation for the clock correction alone it is sometimes convenient to employ the formula

$$\text{A. R.} = T_m + \Delta T + A\,a + B\,b \begin{cases} + C.\,c' \\ \text{or} \\ - 0^s.015 \sec \delta. \end{cases}$$

The quantities

$$A = \frac{\sin(\varphi - \delta)}{\cos \delta}, \quad B = \frac{\cos(\varphi - \delta)}{\cos \delta}, \quad C = \sec \delta, \quad D = \tan \delta.$$

are given in Prof. WATSON'S (ms.) Reduction Tables for each star.

Where the hourly rate is very unsteady the following process may be used. The mean clock correction from a group of three or more fundamental stars is taken as corresponding to the mean time of the observations. The apparent rates between groups are then formed, and platted on squared paper with the times as abscissas and the apparent hourly rates as ordinates. Each apparent hourly rate is assumed to belong to the middle time between the two groups from which it is derived. A smooth curve is then drawn through the extremities of the ordinates, and the final hourly rate for any time can be at once read from the scale of ordinates. The clock correction at any moment can be had by adding to the clock correction at the last preceding group the area included between the axis of abscissas, the curve, the ordinate through the last preceding clock correction and the ordinate through the time for which the clock correction is required. This area is quickly and accurately measured by an AMSLER'S planimeter.

V.—REDUCTION OF OBSERVATIONS IN DECLINATION.

$$\text{For } \left\{\begin{matrix}\text{Circle West}\\ \text{Circle East}\end{matrix}\right\} \text{greater declinations}$$

$$\text{correspond to } \left\{\begin{matrix}\text{greater}\\ \text{less}\end{matrix}\right\} \text{Circle readings.}$$

The observations are reduced by the formula

$$C_o = C + R_{ref} + R_{mic} + R_{mer} + R_{in} + R_r + R_{fl} + R_{div} + \Delta\varphi.$$

C = the reading of the setting microscope plus the mean of the four microscopes;

R_{ref} = the correction for refraction taken from the Pulkova Tables, unaltered (for the present).

Circle West.

$$R_{ref} \text{ is } \left\{\begin{matrix}\text{negative}\\ \text{positive}\end{matrix}\right\} \text{ for stars } \left\{\begin{matrix}\text{south}\\ \text{north}\end{matrix}\right\} \text{ of the zenith.}$$

Circle East.

R_{ref} is $\left\{\begin{matrix}\text{positive}\\\text{negative}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{south}\\\text{north}\end{matrix}\right\}$ of the zenith.

R_{mic} = the micrometer correction to reduce the place of the star as actually bisected, to the mean between the two fixed horizontal threads of the spider-line reticle, or to 10.0 revolutions for the glass reticle.

Circle West and East.

R_{mic} is *positive*, when the micrometer reading on the star is *less* than the reading on the mean of the fixed threads (the "micrometer-zero"); *negative* when the reading on the star is *greater* than the micrometer-zero.

R_{mer} = the reduction to the meridian can be computed from

$$R_{mer} = \pm\left[\frac{2\sin.^2\frac{1}{2}t.}{\sin.1''.}\cdot\frac{\sin.2\delta}{2} + \frac{n.\sin t.\cos^2\delta}{\sin.1''.}\right]$$

The second term will only be sensible when the instrumental n is large, and then only for equatorial stars observed at side threads.

For stars seen *direct* the upper sign relates to *Circle East*, the lower to *Circle West*. For stars S. P. the declination is counted over the pole. For stars seen *reflected* the upper sign relates to *Circle West*, the lower to *Circle East* for stars U. C.

If δ is always taken less than 90°, and the numerical value of R_{mer} is computed regardless of sign as in the following table, then

Circle West (stars seen directly.)

R_{mer} = *minus* for North Stars U. C.
= *plus* " South "
= *plus* " North " L. C.

Circle West (stars seen by reflection.)

R_{mer} = *plus* for North Stars U. C.
= *minus* " South "
= *minus* " North " L. C.

Circle East (stars seen directly.)

R_{mer} = *plus* for North Stars U. C.
= *minus* " South "
= *minus* " North " L. C.

Circle East (stars seen by reflection.)

R_{mer} = *minus* for North Stars U. C.
= *plus* " South "
= *plus* " North " L. C.

The numerical value of R_{mer} can be taken directly from COFFIN and HUBBARD'S Reduction Tables, Washington Astronomical Observations, 1845, Vol. I, Appendix I, p. 78, part of which is reprinted on pages 90 and 91.

HOUR-ANGLE.

Dec.		10ˢ	15ˢ	20ˢ	25ˢ	30ˢ	35ˢ	40ˢ	45ˢ	50ˢ	55ˢ	60ˢ
1°	89°	0″.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03
2	88	.00	.00	.01	.01	.02	.02	.03	.04	.05	.06	.07
3	87	.00	.00	.01	.02	.03	.04	.05	.06	.07	.09	.10
4	86	.00	.00	.01	.02	.03	.05	.06	.08	.09	.11	.14
5	85	.00	.01	.02	.03	.04	.06	.07	.10	.12	.14	.17
6	84	0.01	0.01	.02	0.04	0.05	0.07	0.09	0.11	0.14	0.17	0.20
7	83	.01	.01	.03	.04	.06	.08	.10	.13	.16	.20	.24
8	82	.01	.02	.03	.05	.07	.09	.12	.15	.19	.23	.27
9	81	.01	.02	.03	.05	.08	.10	.13	.17	.21	.26	.30
10	80	.01	.02	.04	.06	.08	.11	.15	.19	.23	.28	.34
11	79	0.01	0.02	0.04	0.06	0.09	0.12	0.16	0.21	0.26	0.31	0.37
12	78	.01	.02	.04	.07	.10	.13	.18	.22	.28	.33	.40
13	77	.01	.03	.05	.07	.11	.14	.19	.24	.30	.36	.43
14	76	.01	.03	.05	.08	.11	.16	.20	.26	.32	.39	.46
15	75	.01	.03	.05	.08	.12	.17	.22	.28	.34	.41	.49
16	74	0.01	0.03	0.06	0.09	0.13	0.18	0.23	0.29	0.36	0.44	0.52
17	73	.01	.03	.06	.09	.14	.19	.24	.31	.38	.46	.55
18	72	.02	.04	.06	.10	.14	.20	.26	.33	.40	.48	.58
19	71	.02	.04	.07	.10	.15	.21	.27	.34	.42	.51	.60
20	70	.02	.04	.07	.11	.16	.21	.28	.35	.44	.53	.63
21	69	0.02	0.04	0.07	0.11	0.16	0.22	0.29	0.37	0.46	0.55	0.66
22	68	.02	.04	.08	.12	.17	.23	.30	.38	.47	.57	.68
23	67	.02	.05	.08	.12	.17	.24	.31	.40	.49	.59	.71
24	66	.02	.05	.08	.13	.18	.25	.32	.41	.51	.61	.73
25	65	.02	.05	.08	.13	.18	.26	.33	.42	.52	.63	.75
26	64	0.02	0.05	0.09	0.13	0.19	0.26	0.34	0.43	0.54	0.65	0.77
27	63	.02	.05	.09	.14	.20	.27	.35	.45	.55	.67	.79
28	62	.02	.05	.09	.14	.20	.28	.36	.46	.56	.68	.81
29	61	.02	.05	.09	.14	.21	.28	.37	.47	.58	.70	.83
30	60	.02	.05	.09	.15	.21	.29	.38	.48	.59	.71	.85
31	59	0.02	0.06	0.10	0.15	0.22	0.30	0.38	0.49	0.60	0.73	0.87
32	58	.02	.06	.10	.15	.22	.30	.39	.50	.61	.74	.88
33	57	.02	.06	.10	.16	.22	.31	.40	.51	.62	.75	.90
34	56	.03	.06	.10	.16	.23	.31	.40	.51	.63	.77	.91
35	55	.03	.06	.10	.16	.23	.32	.41	.52	.64	.78	.92
36	54	0.03	0.06	0.10	0.16	0.23	0.32	0.41	0.53	0.65	0.78	0.93
37	53	.03	.06	.10	.16	.24	.32	.42	.53	.65	.79	.94
38	52	.03	.06	.11	.17	.24	.32	.42	.54	.66	.80	.95
39	51	.03	.06	.11	.17	.24	.33	.43	.54	.67	.81	.96
40	50	.03	.06	.11	.17	.24	.33	.43	.54	.67	.81	.97
41	49	0.03	0.06	0.11	0.17	0.24	0.33	0.43	0.55	0.67	0.82	0.97
42	48	.03	.06	.11	.17	.24	.33	.43	.55	.68	.82	.98
43	47	.03	.06	.11	.17	.24	.33	.43	.55	.68	.82	.98
44	46	.03	.06	.11	.17	.24	.33	.44	.55	.68	.82	.98
45	45	0.03	0.06	0.11	0.17	0.24	0.33	0.44	0.55	0.68	.82	.98

HOUR ANGLE.

Dec.		65ˢ	70ˢ	75ˢ	80ˢ	85ˢ	90ˢ	95ˢ	100ˢ	105ˢ	110ˢ	115ˢ	120ˢ
1°	89°	0.04	0.05	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.14
2	88	.08	.09	.11	.12	.14	.15	.17	.19	.21	.23	.25	.27
3	87	.12	.14	.16	.18	.20	.23	.26	.28	.31	.34	.37	.41
4	86	.16	.19	.21	.24	.27	.31	.34	.38	.42	.46	.50	.55
5	85	.20	.23	.27	.30	.34	.38	.42	.47	.52	.57	.62	.68
6	84	0.24	0.28	0.32	0.36	0.41	0.46	0.51	0.57	0.62	0.68	0.75	0.82
7	83	.28	.32	.37	.42	.48	.53	.60	.66	.73	.80	.87	.95
8	82	.32	.37	.42	.48	.54	.61	.68	.75	.83	0.91	0.99	1.08
9	81	.36	.41	.47	.54	.61	.68	.76	.84	0.93	1.02	1.11	.21
10	80	.40	.46	.52	.60	.67	.76	.84	.93	1.02	1.13	1.23	.34
11	79	0.43	0.50	0.57	0.65	0.74	0.83	0.92	1.02	1.12	1.23	1.34	1.47
12	78	.47	.54	.62	.71	.80	.90	1.00	.11	.21	.34	.46	.60
13	77	.51	.59	.67	.76	.86	.97	.08	.19	.31	.45	.57	.72
14	76	.54	.63	.72	.82	.92	1.04	.15	.28	.40	.55	.68	.84
15	75	.58	.67	.77	.87	.98	1.10	.23	.36	.50	.65	.80	.96
16	74	0.61	0.71	0.81	0.92	1.04	1.17	1.30	1.44	1.59	1.75	1.90	2.08
17	73	.64	.75	.86	0.98	.10	.23	.38	.52	.68	.84	2.01	.19
18	72	.68	.78	.90	1.03	.16	.30	.45	.60	.76	1.94	.12	.31
19	71	.71	.82	.94	.07	.21	.36	.52	.68	.84	2.03	.22	.42
20	70	.74	.86	.99	.12	.27	.42	.58	.75	.93	2.12	.32	.52
21	69	0.77	0.89	1.03	1.17	1.32	1.48	1.65	1.82	2.01	2.21	2.41	2.63
22	68	.80	.93	.06	.21	.37	.53	.71	.89	.09	.29	.50	.73
23	67	.83	.96	.10	.25	.42	.59	.77	1.96	.16	.37	.59	.82
24	66	.86	0.99	.14	.30	.46	.64	.83	2.03	.23	.45	.68	.92
25	65	.88	1.02	.18	.34	.51	.69	.89	.09	.29	.53	.76	3.01
26	64	0.91	1.05	1.21	1.37	1.55	1.74	1.94	2.15	2.36	2.60	2.84	3.09
27	63	.93	.08	.24	.41	.59	.79	1.99	.21	.43	.67	.92	.18
28	62	.96	.10	.27	.45	.63	.83	2.04	.26	.49	.74	2.99	.26
29	61	0.98	.13	.30	.48	.67	.87	.09	.31	.54	.80	3.06	.33
30	60	1.00	.16	.33	.51	.71	.91	2.13	.36	.60	.86	.12	.40
31	59	1.02	1.18	1.36	1.54	1.74	1.95	2.17	2.41	2.65	2.91	3.18	3.47
32	58	.04	.20	.38	.57	.77	1.98	.21	.45	.70	2.96	.24	.53
33	57	.05	.22	.40	.59	.80	2.02	.25	.49	.74	3.01	.29	.59
34	56	.07	.24	.42	.62	.83	.05	.28	.53	.78	.06	.34	.64
35	55	.08	.26	.44	.64	.85	2.08	2.31	.56	.82	3.10	.39	.69
36	54	1.10	1.27	1.46	1.66	1.87	2.10	2.34	2.59	2.85	3.14	3.43	3.73
37	53	.11	.28	.47	.68	.89	.12	.37	.62	.88	.17	.47	.77
38	52	.12	.30	.49	.70	.91	.14	.39	.65	.91	.20	.50	.81
39	51	.13	.31	.50	.71	.93	.16	.41	.67	.93	.23	.53	.84
40	50	.13	.32	.51	.72	.94	.17	.42	.68	.95	.25	.55	.87
41	49	1.14	1.32	1.52	1.73	1.95	2.19	2.44	2.70	2.97	3.27	3.57	3.89
42	48	.15	.33	.52	.73	.96	.20	.45	.71	.98	.28	.59	.90
43	47	.15	.33	.53	.74	.97	.20	.46	.72	2.99	.29	.60	.92
44	46	.15	.33	.53	.74	.97	.21	.46	.73	3.00	.30	.60	.92
45	45	1.15	1.34	1.53	1.74	1.97	2.21	2.46	2.73	3.00	3.30	3.61	3.93

R_{in} = the correction for inclination of thread.

In our ordinary practice each star is bisected twice on threads at equal hour angles + and —; and R_{in} is thus eliminated.

R_r = the correction for runs.

R_{fl} = the correction for flexure = h sin z.

Circle West.

R_{fl} is $\left\{\begin{matrix}\text{positive}\\\text{negative}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{south}\\\text{north}\end{matrix}\right\}$ of the zenith.

Circle East.

R_{fl} is $\left\{\begin{matrix}\text{negative}\\\text{positive}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{south}\\\text{north}\end{matrix}\right\}$ of the zenith.

R_{div} = correction for division errors.

$\Delta\Phi$ = the reduction of the latitude from the mercury basin (for reflected stars only) to the centre of the cube of the axis.

$\Delta\Phi$ is $\left\{\begin{matrix}\text{minus}\\\text{plus}\end{matrix}\right\}$ for stars $\left\{\begin{matrix}\text{north}\\\text{south}\end{matrix}\right\}$ of the zenith.

The sum of C and the various R's is C_o = the corrected circle reading.

If N_e, N_w is the Nadir-Point, Circle E and Circle W, and E_e and E_w, the Equator-Point, Circle East and Circle West; Φ = the latitude; δ = a star's declination. Then

Circle West.

$$\delta_w = C_o - E_w = C_o - (180^\circ + N_w - \Phi).$$

Circle East.

$$\delta_e = E_e - C_o = N_e + \Phi - C_o - 180^\circ.$$

VI. RESULTS OF INDIVIDUAL OBSERVATIONS WITH THE MERIDIAN CIRCLE FROM 1883 JULY, TO 1883 DECEMBER 31, BY MR. JOHN TATLOCK, JR.

In order to give some data for judging of the performance of the Meridian Circle, Mr. TATLOCK has collected all those observations of declinations of stars made since July 1883, for which as many as three determinations are available, and they are given in what follows:

The declinations are derived from Nadir observations, and an assumed latitude of +43° 4′ 36″. 64 (U. S. Coast Survey value), using the Pulkova refractions unaltered. It is probable that both the latitude and the refraction will be slightly changed by the series of observations of which these positions form parts. And the positions here given are to be considered only as one part of the study of the performance of the circle, the other parts having been fully set forth in what precedes.

No corrections for flexure or division have been applied.

The positions serve for 1883.0.

α Andromedae. R. A = $0^h\ 2^m\ 20^s$.

Date.			
Nov. 28, 1883	+28°	26′	39.″2
Dec. 4,			39. 0
Dec. 5,			39. 6

β Ceti. $0^h\ 37^m\ 43^s$.

Nov. 28,	—18°	37′	43.″8
Dec. 4,			45. 0
Dec. 5,			43. 7

γ Cassiopeae. $0^h\ 49^m\ 39^s$.

Dec. 5,	+60°	4′	56.″7
Dec. 8,			56. 3
Dec. 10,			57. 3

α Ursæ Minoris. 1 15^m 52^s.

Oct. 16,	+88° 41′	6.″1
Oct. 23,		4. 7
Nov. 28,		5. 4
Dec. 4,		6. 0
Dec. 8,		3. 8
Dec. 10,		5. 1

ν Ceti. 1^h 54^m 30^s.

Nov. 28,	—21° 38′	42.″8
Dec. 4,		42. 9
Dec. 10,		42. 0

α Ursæ Minoris S. P. 13^h 15^m 52^s.

Date.		
Sept. 25, 1883.	+88° 41′	5″.4
Oct. 16,		5 .4
Oct. 18,		6 .3
Oct. 19,		6 .3
Nov. 1,		6 .2
Dec. 4,		5 .0
Dec. 10,		5 .9

η Ursæ Majoris. 13^h 42^m 56^s.

Sept. 25,	+49° 53′	51″.2
Oct. 16,		51 .4
Oct. 18,		52 .9

α Bootis. 14^h 10^m 19^s.

Sept. 25,	+19° 47′	29″.9
Oct. 16,		31 .4
Oct. 18,		29 .7

β Ursæ Minoris. 14^h 51^m 3^s.

Sept. 25,	+74° 37′	61″.2
Oct. 16,		60 2.
Oct. 18,		59 .9

δ *Ursæ Minoris.* $18^h\ 10^m\ 4^s$.

Date.			
Oct. 2, 1883,	+ 86°	36′	35.″7
Oct. 10,			36. 7
Oct. 18,			36. 9

110 *Herculis.* $18^h\ 40^m\ 38^s$.

Oct. 3,	+ 20°	26′	6.″2
Oct. 10,			6. 3
Oct. 15,			6. 4

o Draconis. $18^h\ 49^m\ 28^s$.

Oct. 10,	+ 59°	14′	42.″8
Oct. 15,			43. 0
Nov. 1,			43. 4

λ *Aquilœ.* $19^h\ 0^m\ 2^s$

Oct. 2,	— 5°	3′	25.″4
Oct. 3,			26. 3
Oct. 10,			25. 0

The three stars below depend in both co-ordinates upon the system of publication XIV of the Astronomische Gesellschaft, having been reduced differentially from stars of the Berlin Jahrbuch.

Lacaille 8252.

Date.	R. A. h.	m.	s.	Dec.		
Sept. 26,	19	47	17.36	—24°	13′	49.″7
Oct. 10,			17.45			50. 4
Oct. 15,			17.24			50. 7

Lacaille 8777.

Nov. 1,	21	12	59.65	—26°	50′	0.″7
Nov. 2,			59.70			3. 9
Nov. 6,			59.48			3. 6

Lacaille 9547.

Nov. 10,	23	33	40.15	—33°	22′	55.″8
Nov. 17,			40.10			55. 6
Dec. 14,			39.98			51. 4

VII. LIST OF ONE HUNDRED AND ELEVEN NEW DOUBLE STARS AND TWO NEBULÆ, ENCOUNTERED IN THE SWEEPS FROM DECEMBER 1881, TO JANUARY 1884.

NOTE: The numbers are in continuation of those in Vol. I., pp. 77–89. These stars have all been discovered with a power of 145; those marked Caroline I. with the six inch telescope at Caroline Island in the South Pacific Ocean.

No	Name.	R. A. 1880.	Decl. 1880.	p.	s.	Mags.	Remarks.
		h. m. s.	° ′	°	″		
61	W_1B, 0 h, 468.	0 28 57	+14 13	250	1	9.2..11	
62	.....	0 56 5:	— 9 30:	310	¾	10 ..10	
63	D M, +11°, 355.	2 27 53	+11 18	280	1	9.0.. 9.5	
64	D M, + 1°, 456.	2 39 20	+ 1 3	216	5½	8.5..12	
65	.....	3 25 24	— 6 6	2	4	9 ..10	
66	Ll. 7187.....	3 46 48	— 8 51	265	10	8 ..12	
67	Ll. 7249.....	3 48 54	—13 4	155	3	8 .. 9	
68	.....	3 49 50	—17 19	190	4	10 ..11	
69	D M+18°, 565 .	3 50 53	+18 35	195	1½	10 ..10.5	
70	W_1B, 3 h, 996.	3 52 11	— 5 15	270	4	8.8.. 9.5	
71	W_1B, 3 h, 1005.	3 52 21	— 9 15	150	3	9 ..12	
72	.....	3 59 4	— 9 4	210	2	10 ..10	
73	A O e_2, 3901...	5 17 20	—17 23	50	2	9 ..11	
74	.....	5 17 58	—17 18	50	6	10 ..10	
75	Berlin charts..	5 21 55	— 8 49	90	4	9 ..10	
76	Berlin charts..	5 28 36	—14 27	230	1	10 ..10	
77	Lam. 35.....	5 39 45	—15 13	310	2	10 ..10.5	
78	Berlin charts..	5 42 57	—12 45	174	1½	9 .. 9	
79	.....	6 14 13	— 5 57	315	2	10 ..12	

No	Name.	R. A. 1880.	Decl. 1880.	p.	s.	Mags.	Remarks.
		h. m. s.	° ′	°	″		
80	Berlin charts..	6 31 41	—14 9	134	4	9.0.. 9.0	S. p. a dup. (Howe) 34°, 9″ 8..11.
81	.....	6 33 31	—13 56	190	4	10 ..11.5	
82	.....	6 45 18	—11 38	245	1½	9 ..10	
83	Berlin charts..	6 45 36	—11 17	160	1½	10 ..10	
84	.....	6 57 43	— 8 17	40	6	10 ..10	
85	... ...	7 7 39	—19 41	210	1½	10.5..11.5	
86	.....	7 9 20	—25 46	280	3	10 ..11	
87	.....	7 14 58	—21 39	275	5	9.8.. 9.8	H. 3950 is near = A O e_2 6604.
88	A O e_2 6629 ...	7 15 5	—22 40	270	4	9.2..11	
89	.....	7 33 55	—16 25	230	3	9.5..11	
90	A O e_2 7228 ...	7 35 36	—16 12	290	4	9.5.. 9.8	
91	.....	7 36 0	—20 4	225	1½	9.3..11.5	
92	.....	7 49 28	—16 20	265	2	10.5..12	
93	.....	7 53 40	—10 8	210	1	10 ..11	
94	Ll. 15649	7 54 14	—13 31	280	3½	9.0..11	
95	.....	8 11 8	—28 25	160	3½	9.5..10.5	
96	.....	8 20 39	—22 19	315	3½	9.4..10.5	
97	D M. +14°, 1934	8 30 56	+14 40	250	3	11 ..11	
98	A O e_2 9673 ...	9 18 56	—23 17	175	2½	9.8..10.5	
99	.....	9 42 28	—27 2	230	2½	9.8..11	
100	.....	10 9 58	—17 50	220	2	10.2..11.3	
101	A O e_2 10498 ..	10 11 5	—20 4	125	1½	6.5.. 9	?
102	.....	10 14 14	—20 45	170	2	10.4..11.3	
103	Lam. 158.....	10 14 47	—15 45	325	2	9.5..10.5	
104	.....	10 14 50	—16 7	200	4	10 ..10	
105	A Oe_2, 10588...	10 18 0	—19 19	120	1	9? ..10?	Hazy.
106	Stone 5791.....	10 28 35	—54 46	250	2	8.5.. 9	Caroline I.

No	Name.	R. A. 1880	Dec 1880	p	s	Mags.	Remarks.
		h. m. s.	° ′	°	″		
107	.....	10 29 40	−17 19	310	1	10.5..11	Hazy; mags.?
108	B. B. vi, 63?...	10 33 16	−16 57	37	1	8.4.. 9.1	
109	AOe$_2$, 10830...	10 37 21	−20 24	140	2½	9.8..10.5	
110	AOe$_2$, 10860-1.	10 40 1	−19 5	270	3	9 ..10	
111	.....	10 49 38	−17 40	60	10	9 ..11.5	A yellow, B blue.
112	.....	11 31 28	−60 14	350	1½	8.5.. 9.5	Caroline I.
113	Berlin charts..	11 47 45	−13 43	260	4	9.5..10	
114	Lac. 4936.....	11 48 58	−55 25	230	2	7.5.. 8	Ditto.
115	.....	11 57 40	−57 5	240	1½	8.5.. 9.5	Ditto.
116	Lac. 5223.....	12 31 24	−55 16	205	1½	7.3.. 9.3	Caroline I.
117	DM. +8°, 2644..	12 43 4	+ 8 18	200	2	9 .. 9	p = 20° ?
118	....	13 1 16	−52 5	200	1½	9.5.. 9.5	Caroline I.
119	Lac. 5434.....	13 6 59	−62 57	40	1½	7.5..10	Ditto.
120	Ll. 27090	14 46 46	+ 8 16	220	15	7.7..10	
121	Stone 8250.....	15 3 33	−51 38	220	3	7.5.. 9	Ditto.
122	Lam. 1868.....	15 28 26	−10 7	345	2½	10.5..11	
123	W. M.Zones,255	15 35 56	−21 32	135	4½	9 .. 9.8	
124	Lac. 6488.....	15 36 11	−50 24	210	2	7 .. 9	Ditto.
125	.....	15 53 9	−20 4	305	6	9.2.. 9.5	
126	.....	15 53 45	−20 6	40	3	9 ..11	
127	.....	15 58 35	−20 10	130	3	8.5..10.7	
128	AOe$_2$, 15527...	16 13 16	−18 7	255	4	8.7.. 9.7	
129	....	16 17 47	−18 19	135	5	9.2..10.5	
130	.....	16 19 31	−18 13	190	1	10.2..10.2	
131	Stone 9221.....	16 50 15	−56 25	125	2	7.5..10	Caroline I.
132	.....	17 11 36	−23 52	35	5	9 ..10	
133	AOe$_2$, 16701...	17 16 35	−21 36	170	1	8.8.. 9.2	
134	AOe$_2$, 16726...	17 17 42	−21 20	155	8	6.5..12	
135	AOe$_2$, 16764-5.	17 18 44	−19 11	105	3	9.0..11.5	

No	Name.	R. A. 1880.	Decl. 1880.	p.	s.	Mags.	Remarks.
		h. m. s.	° ′	°	″		
136	Lac. 7315.....	17 23 16	−40 57	95	1	8.0.. 8.5	Ditto.
137	.....	17 31 17	−19 1	255	1	10 ..11	
138	AOe_2, 17072...	17 34 19	−17 54	270	3	9.5..10.5	
139	Ll. 32716.....	17 48 13	−11 37	140	6	7.5..11	
140	.....	17 53 56	−20 47	260	2½	9 ..10	
141	AOe_2, 17868...	18 7 0	−23 42	30	2	9.5..10.5	
142	Ll. 33492	18 7 58	−11 15	225	1½	10.0..10.5	
143	Lam. 549.....	18 10 54	−16 54	110	3	10.0..11	β 463?
144	Y. 7794.....	18 18 29	−21 6	45	7	8.8.. 8.8	
145	Lam. 667.....	18 35 53	−15 30	40	1	10 ..10	
146	.....	18 37 27	−17 39	230	1	10 ..10.5	
147	AOe_2, 18713...	18 42 49	−17 2	295	3	9.7..11.5	Hazy.
148	AOe_2, 18742...	18 43 56	−16 54	20	15	9 ..13	
149	.....	19 15 16	−18 37	185	1¼	10.5..10.5	
150	Ll. 36456	19 15 56	−11 51	110	1½	9.8..11.5	AB.
	.....	.....	.....	150	20	9.8..12	AC.
151	.....	19 16 52	−18 44	210	2	10.3..10.7	
152	AOe_2, 19672...	19 25 4	−17 4	190	1½	9.5..10	
153	.....	19 48 58	−13 24	120	3	10 ..11	
154	.....	19 58 56	−14 46	215	2	10.5..10.5	
155	W_1 B, 19_h, 1463	19 59 43	−13 43	270	1½	8.0.. 9.5	
156	Lam. 7278.....	20 0 3	+ 1 39	255	1½	9.8..10	
157	Lam. 477.....	20 8 35	−24 34	230	3	10 ..11	
158	Lam. 7462.....	20 15 14	+ 2 28	40	2	9.5..10	
159	.....	20 23 7	−12 41	280	2	11 ..11.5	
160	$W_1B, 20^h$, 612.	20 26 10	−13 57	185	1½	9.2.. 9.2	
161	Ll. 39532.....	20 26 17	− 9 18	60	2	9 ..10.5	
162	.....	20 37 33	−14 8	140	2½	1[illegible] ..11	
163	Ll. 40034.....	20 38 17	− 9 42	100	2	9 .11	

No	Name.	R. A.,1880.			Decl. 1880.		p.	s.	Mags.	Remarks.
		h.	m.	s.	°	′	°	″		
164	$W_1B, 20^h$, 988.	20	39	58	—12	44	120	5	9 ..11	
165	AOe_2, 21032...	20	53	49	—18	7	150	4	8.3..10.5	
166	AOe_2, 21387...	21	19	39	—21	56	60	3	9 ..12	
167	....	21	36	53	—14	43	300	3	11 ..11.5	
168	.. ..	21	54	..	—15	20	344	2½	10 ..11	
169	AOe_2, 22195...	22	24	20	—19	48	170	1½	8.5..10	
170	W. M. Z. 146..	23	6	24	—22	35	290	1½	9.2..10	
171	W_1 B, 22^h, 195	23	11	32	+16	12	10	3	9 ..10	

TWO NEW NEBULÆ.

No.	R. A. 1860; N. P. D.	Description
24. 1882. April 20.	$12^h\ 30^m\ 56^s$; 87° 44′.	S. F. B M. Stell. N.
May 14.		as before.
25. 1882. May 14.	$15^h\ 1^m\ 12^s$; 100° 40′.	S. F. Stell. N. n. p. G. C. 4055.

The following known nebulæ have been seen and identified:

G. C. 156; 185; 418 (extended 45°); 551; 582; 586; 656 (F. Stell. N., exactly s. of a star 10 mag.); 707, (stellar p. F.); 933; 964, (F, N, irr. fig. Ex. n. and s.); 1539; 1559; 1613, (cl. with a central vacuity, which is circular and 2′ in diameter): 1838, (p. B. Ex. 150°, 2′ long; connected with stars 13....14. Nuc. in n. p. end of Neb. 1882, April 6, and April 10, p, B.); 1886; 2023; 2294; 2296; 2341 (double nucleus?); 2944; 2979; 2999; 3005 (not large 3′ ±;) 3090; (R. A. $12^h\ 28^m\ 0^s$, N. P. D. 89° 27′; F. S. b. M.); 3125; 3166; 3660; 4055, (F. L. 4′ in diameter, probably its R. A. to be corrected by + 3ˢ); 4293; 4333; 4397; 4414; 4510; 4543; 4608; 4628; 4738; (*not* p. s., Ex. 90° b. M., 4′ long, 1½′ wide); 5648, (extended); 5651 (extended 120°); 5652 (D'ARREST says p. B; v. F., June 7, 1882); 5657 (N. P. D. of supplement to G. C. to be corrected by —1°.)

VIII. OBSERVATIONS OF 119 RED OR COLORED STARS BETWEEN 1881 DECEMBER 26 AND 1883 DECEMBER 31.

N. B.—The numbers are in continuation of the observations printed in Vol. I., page 161. The stars are those met in the sweeps.

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
85	B. B. vi, no. 61....	0 21 44	+15 49	83.70	Orange yellow; 7.3; Arg. 9.3. !
86	B 48=T Arietis....	2 41 38	+17 1	81.99	Red; mag. 8.0. Hazy sky.
87	54 Arietis.....	3 1 33	+18 20	81.99	Fine or. yell.; 7.2. D. M. 6.5 mag. Sky hazy.
88	W_2 B. 4.^{h} 488.....	4 24 0	+23 5	83.91	7.5 strong reddish yellow; Bessel 7.8; D. M. 7.4.
89	.....	4 59 41	—22 3	82.10	Fine red; 9.5 mag. Feb. 7–8.
90	B. 97=ε Leporis...	5 0 22	—22 32	82.10	Flaming yellow; not red.
91	Ll. 10976.....	5 41 17	+ 2 52	82.04	Reddish; 7.8 mag.
92	Ll. 12825.....	6 33 47	—14 2	82.05	Or. yell.; 5.8 mag.
93	....	6 47 15	— 4 27	82.14	Or. red; 8.7 mag. { Feb. 22. Feb. 24.
94	B. 157=o' Can. maj.	6 49 9	—24 2	82.15	Brilliant or. red.
95	.....	6 57 1	— 8 16	82.14	Feb. 22, 7.5 mag; Mar. 13, 8 mag.; reddish star in Cl. M. 50.
—	B. 163.....	6 57 11	— 8 10	.....	I did not see this star 1882 Feb. 22, 24, and Mar. 13.
96	W_1 B, 213.....	7 8 26	— 9 3	82.15	Red.; mag. 9; Bessel (8).

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
97	A Oe_2, 6521.....	7 11 36	--22 36	82.15	Arg. mag. is (8) Dup. 300°, 70″, 9.3, 11, A reddish, B, blue; Feb. 24; Mar. 2, and Mar. 10.
98	B. 178.....	7 23 36	—10 5	82.15	Or. red; 7 mag.
99	h. 3973.....	7 26 37	—20 41	82.11	Dup. 40°, 7″, 8.5 —9.5 A. white B. a remarkable dull red.
100	B. B. vi, 109.....	7 33 59	—16 35	82.25	Yellow; 6.5 mag.
101	.....	7 34 39	—18 46	82.19	Reddish; 8.0 mag.
102	A. Oe_2, 7226.....	7 35 32	—16 14	82.25	Dup. 150°, 15″; A. reddish, B. blue.
103	A. Oe_2, 7906.....	7 59 25	—17 20	82.19	Or. yell.; 6–7 mag.
104	B. B. vi, 34.....	8 14 54	—23 5	82.21	Or. yellow; 6.5 mag.; Mar. 18—Mar. 27.
105	B. 202= β 207 = Ll. 17091.....	8 33 44	—19 19	82.15	Dup. A. or. red; 6.5 mag; B. blne; 9 mag.
106	B. 211.....	8 48 37	+17 41	82.11	Or. red; 8 mag.
107	Ll. 18646	9 22 15	— 9 30	82.27	Yellow.
108	Ll. 18650	9 22 29	— 9 28	82.27	Yellow; Dup. 40°,, 12″, 7.5—10.5.
109	W_1B., 453	9 22 31	— 9 48	82.27	Or. yell.; mag. 7; Bessel (8).
110	A O $e_2$9763.....	9 23 41	--20 14	82.28	Or. yell.; 6.5 mag.
111	Ll. 18762	9 26 06	— 9 51	82.27	Or. yell.; 6.5 mag.
112	Ll. 18996	9 33 55	—10 13	82.30	Reddish yellow; 8 mag.
113	Ll. 19796	10 3 30	—12 47	82.27	Or. yellow; 7.5 mag.
114	....	10 4 44	—11 45	82.27	Yellow; 4–5 mag.
115	B. B. vi, 5	10 5 36	—18 22	82.30	Reddish yellow; 6.5 mag.
116	B. B. vi, 18	10 12 11	—20 26	82.33	Reddish yellow; (3n) 7.0.
117	B. 242.....	10 31 38	—12 46	82.30	Or. red; mag. 6.
118	Ll. 20671..	10 36 14	—13 09	82.30	Or. red; 7. mag.

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
119	B. 250—R. Crateris.	10 54 39	—17 41	82.29	9.7 mag; very red; a blue star, 11 mag.; prec. R. 4ˢ.5.
				82.30	Certainly not above 9.0 mag.
120	A O e_2 11453	11 25 50	—23 53	83.28	Dull or. red; 8.2 mag.
121	Lac. 5384.....	12 58 28	—51 28	83.	Reddish; 7.5 mag. (Caroline I.) Stone's mag. 6.
122	.....	13 10 24	—63 57	83.	Brick red; 7.7 (Caroline I.)
123	Ll. 24769	13 15 43	—13 47	82.35	Or. yell.; 7 mag.
124	*M.* Virginis = Ll. 25258.....	13 35 19	— 8 06	82.35	Or. yell.; 5.5 mag.
125	θ Apodis	13 53 41	—76 13	83.	Fine or. red; 5. mag. (Caroline I).
126	B. 344.....	14 59 56	—15 47	82.	Not "very red," but a fine or. yell.; mag. 6.
127	.....	15 37 22	— 1 19	82.43	Deep red; 10.3 mag.
				82.44	Red; 10 mag.
128	A O e_2, 15000.....	15 47 49	—20 28	82.43	Or. red; 8–9 mag.
				82.49	Or. red; 7.8.
129	A O e_2, 15036–7....	15 49 22	—20 25	82.43	Or. red; 8 mag.
				82.49	Or. red; 7.3 mag.
130	A O e_2, 15053.....	15 49 56	—15 29	82.45	Slightly reddish; 8 mag.
131	A O e_2, 15055.....	15 50 17	—15 41	82.45	Fine or. yell.; 7 mag.
132	A O e_2, 15982	16 37 15	—18 19	82.48	Orange; 7.2 mag.
133	Lac., 7152.....	17 4 5	—56 44	83.	Red; 7.0 mag. Stone's mag. 6.,(Caroline I.)
134	A O e_2, 16779–80...	17 19 41	—21 22	82.48	Reddish yellow; 7.5 mag.
				82.49	Reddish yellow; 7.5 mag.
					A O e. has (6.7) and 7. Moonlight.
135	B. 410	17 22 39	—19 23	82.51	Very red; 7.5 mag.

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
136	B. B. vi 59.....	17 26 31	−22 5	82.49	Reddish; 7.7 mag.
					ARGELANDER gives (8.0) mag.
					W. T. Z. 245, gives (9) mag.
					July 1 and 3; 7.5 mag.
137	Ll. 32694–5–6.....	17 47 27	−11 19	82.54	Strong yell.; 6.7 mag.
138	Ll. 32870.....	17 51 58	−11 51	82.58	Strong reddish; 7.8 mag.
139	A O e_2, 17509	17 55 15	−22 54	82.49	Orange; in trifid neb; 8–9 mag.
140	Ll. 33012	17 55 38	−12 19	82.58	Strong reddish; 6.8 mag.
141	A O e_2, 17627–8....	17 59 36	−22 3	83.61	Fiery yellow; 7.5 mag.
142	A O e_2, 17658–9....	18 0 27	−22 15	83.61	Yellow, 7.8 mag.
143	W. M. Z.....	18 0 30	−21 52	83.61	Reddish yellow; 7.7 mag.
144	Ll. 33301.....	18 3 3	−11 46	82.54	Red; 7.0 mag.
145	A O e_2, 17741–2...	18 3 6	−26 3	82.49	Or. yell. mag. 7.0, Arg. (8) and (7).
146	Ll. 33334.....	18 4 5	−11 3	82.54	Reddish; 7–8 mag.
147	Ll. 33361.....	18 4 46	−11 20	82.54	Reddish 6–7 mag.
148	.....	18 5 59:	−18 58:	82.54	Or. red; 9 mag.
149	.....	18 6 36	−19 16	82.54	Very deep dull red; 8.7 mag.
150	.....	18 6 44:	−19 7:	82.54	Red; 8.8 mag.
151	A O e_2, 17871.....	18 7 03	−21 45	83.61	Yellow; 6. mag.
152	A O e_2, 17917.....	18 8 24	−18 58	83.57	Or. red 7.5 mag.
153	.....	18 8 31	−20 0	83.61	Good red star; 9.5
154	Ll. 33605	18 10 43	−12 46	82.58	Reddish 6.7 mag.
155	.....	18 11 34	−13 29	82.58	Deep red; 9.2 mag.
				82.61	Dup. 265°, 40″ 9.2—12.

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
				82.63	9.5, as before.
156	Lac. 7638.....	18 12 10	—61 33	83	Or. red 6 mag. STONE 5.4 mag. (Caroline I.)
157	AOe_2, 18084.....	18 14 8	—24 58	82.49	Or red, 6.5 mag.; Arg. (7).
158	W. Z.....	18 16 59	—19 27	83.58	Yellow, 8.8 mag.
159	AOe_2, 18162–3.....	18 17 11	—19 52	83.58	Yellow, 9 mag. Arg. (8) (9).
160	AOe_2, 18165–6–7...	18 17 32	—19 48	83.58	Yellowish red, 9 mag. ARG. (7.8) (7) (8).
161	AOe_2, 18250.....	18 20 59	—21 19	82.52	Red, 8.9 mag.
162	AOe_2, 18263.....	18 21 27	—19 51	83.57	Yellowish red, 8.0 mag.
163	Lamont 90.....	18 24 18	—21 20	82.52	Red, 8.7 mag.
164	.....	18 24 26	—17 30	83.60	Good red, 10 mag.
165	B 446.....	18 25 53	—14 57	82.58	Fine or. red, 5.8 mag.
166	AOe_2, 18501–2= Lam. 648.	18 32 11	—15 09	83.58	Reddish yellow, 9 mag., ARG. (7) (7) LAM. (9).
167	AOe_2, 18577.....	18 35 51	—19 24	82.54	Strong reddish; 7.5 mag.
				82.58	Or. red, 6.5 mag., moonlight.
168	Ll. 34679.....	18 36 51	—11 27	83.56	Strong reddish, mag. 8.5 (?) Ll. gives (7).
169	Ll. 34753.....	18 38 36	—12 43	82.61	Strong reddish, 8.8 mag.
170	Ll. 34764.....	18 38 49	—12 43	82.61	Strong reddish, 8.5 mag.
171	AOe_2, 18676.....	18 41 13	—16 54	82.63	Or. yellow, 7.8 mag.
172	AOe_2, 18827.....	18 47 59	—16 40	82.56	Reddish, 8.5? mag. ARG. has (7).
173	Ll. 35249–50.....	18 49 43	—11 29	82.56	Strong reddish, mag. 8.8. Ll. has (7) and (7.5).
174	AOe_2, 18957–8.....	18 54 24	—22 52	82.61	Orange, 6.7 mag.

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
175	AOe$_2$, 18995–6.....	18 56 30	—22 53	82.61	Red, 8.2 mag.
176	B. 483.....	18 58 0	— 5 52	83.66	7 mag., very red.
177	Ll. 35878.....	19 4 09	—12 20	82.61	Mag. 7.0. B. C. says: "variable."
178	B. 488.....	19 9 19	—17 11	83.60	Yellow red, = T *Sagitarii;* mag. 9.
179	A. Oe$_2$, 19382.....	19 12 17	—16 8	83.66	Red 8.5; sky very hazy; ARG. (7) LAM. (7–8).
				83.69	*Orange* red; 7.5 mag.
180	B. 505.....	19 27 26	—16 38	82.61	*Red;* 7 mag.
				82.63	*Red;* 7.0 mag.
				83.65	Very red; 7 mag.; sky hazy.
				83.66	Very red; 8 mag.; sky hazy.
181	Ll. 37388.....	19 36 17	—14 31	83.65	Yellowish red; 9 mag.; Dup. 9 — — — 12. 60°, 20″.
182	A. Oe$_2$, 19954–5= Lam. 1003.....	19 40 15	—17 22	83.60	Fiery yellow; 7.5 mag.
				83.64	Reddish yellow ——. ARG. (6.7) (7) LAM. (7).
183	W$_1$ B., 1106.....	19 45 03	—13 20	83.65	Or. red; 7.5 mag.; BESSEL (6–7.)
184	W$_1$ B., 1319.....	19 54 23	—14 16	83.65	Orange; 7 mag.; BESSEL (7).
185	A. Oe$_2$, 20216–7–8..	19 58 32	—16 42	83.65	Or. yellow; 7 mag.; ARG. (7) (8) (7.8).
186	D. M. 37°, 3821= W$_2$ B. 258.....	20 7 44	+38 0	83.97	7 mag.; strong red yellow.
187	A. 545.....	20 10 5	—21 41	82.67	7; very red.
				83.74	6.9 mag.; deep dull red.
188	B. 564=70 Aquilae.	20 30 29	— 2 58	83.67	Or. red; 4.5 mag.
189	Lamont 3912.....	20 33 58	— 3 4	83.66	Yellow; 6.5 mag.; LAM. (8–9).

No	Name.	R. A. 1880.	Decl. 1880.	Date.	Remarks.
		h. m. s.	° ′		
190	W_1 B., 1004.....	20 40 50	— 2 56	83.66	Yellow; 7 mag.; Bessel (7).
191	W_1 B., 1069.....	20 43 07	— 1 0	83.66	Yellow; 7 mag.; Bessel (7); Lam. (6.7).
192	W_1 B., 1269.....	20 51 03	+ 0 1	83.66	Yellow, 6.5 mag.; Bessel (7).
193	Lam. 8006.....	20 57 16	— 2 48	83.66	Yellow; 8 Lam. (8.9).
194	W_1 B., 1562.....	21 2 38	— 6 4	83.66	Yellow; 6.5 mag.; Bessel (7) Lamont (8.9).
195	W_1 B., 65.....	21 5 38	— 6 18	83.66	Yellow; 7.5 mag.; B. blue 200° 10″—7.5 — — 11.
196	W_1 B., 140.....	21 8 45	— 6 3	83.66	Yellow; 7.7 mag.; Bessel (7).
197	Lam. 4245.....	21 16 37	— 3 3	83.66	Yellow with blue comp.; 9—10.5.
198	Lam. 8300.....	21 20 09	— 2 13	83.66	Reddish yell.; 9 mag..
199	Lam. 4278.....	21 22 07	— 3 23	83.66	Yellow; 8 mag.
200	B. 596.....	21 40 19	— 2 46	83.66	Very red; 6.7 mag.
201	$W._1$ B., 1139.....	21 50 04	— 5 20	83.66	Or. yell.; 8.7 mag.
202	Lamont 3902.....	22 20 0	—14 43	83.73	9 mag.; reddish yellow.
203	$W._2$ B., 886.....	23 42 32	+27 42	83.70	Reddish yellow; 8.3 Arg. 7.5; W_2 B. 7.5.

IX. OCCULTATIONS OF FORTY STARS BY THE MOON (Immersions).

The first twenty-two occultations were observed for comparison with such as might be recorded by the various Transit of Venus observing parties. They comprise all visible at Madison during the period 1882, October 16th to 1883, January 16th. Some of the stars are too small, however, to have been observed with six-inch telescopes. The observers are denoted by their initials, as follows:

E. S. H. = E. S. HOLDEN. Observations made by eye and ear, using a sidereal chronometer, compared (usually before and after) with the standard clock.

G. C. C. = GEORGE C. COMSTOCK; observations as above.

C. M. C. = C. M. CONRADSON, whose two observations of 1882, December 15th. were recorded on the chronograph.

J. T. = JOHN TATLOCK, JR. Observations recorded on the chronograph.

The times are Madison mean times. The aperture employed was $15\frac{1}{2}$ inches. The power was usually 145. The relative positions of stars and the moon's limb were read from a glass scale in the eyepiece, and are true to about 1′.

Those stars not identified are either not in catalogues, or in several cases they are such as were observed just before clouds covered the sky, so that they could not referred to known stars. The magnitudes assigned to stars near the moon are often quite erroneous, my own in particular being nearly one magnitude too bright.

1882, October 16.

1. A star 2′.5 south of moon's center disappeared at $7^h\ 51^m\ 28^s.73$, Madison m. t. The time is uncertain by $\pm 0^s.5$, The moon was very low, and set before any others could be observed. E. S. H., observer.

1882, October 17.

2. A star (about 10 mag.) 5′ south of moon's N. L. disappeared at $5^h\ 50^m\ 5^s.46$. Fair observation. E. S. H., observer.

3. A star 1′ south of moon's N. L., was lost in the moon's glare at $7^h\ 1^m\ 3^s.66$. This is very nearly the true time of immersion. E. S. H., observer.
4. A star (9 mag.) 7′ south of moon's N. L., lost in the moon's glare at $7^h\ 6^m\ 19^s.79$. This is very nearly the true time of immersion. E. S. H., observer.
5. A star (8 mag.) 12′ south of moon's N. L., disappeared at $7^h\ 10^m\ 30^s.21$. Good observation. E. S. H., observer.
6. A star (8 mag.) $10\frac{1}{2}$′ south of moon's N. L.. at $21^h\ 10^m$ sid. t., disappeared at $7^h\ 31^m\ 57^s.98$. Good observation. E. S. H., observer.
7. A star (8.5 mag) A O e_2, 17728, disappeared at $7^h\ 43^m\ 19^s.45$. E. S. H., observer.
8. A star south following 7, disappeared at $7^h\ 42^m\ 41^s.92$. Good observation. E. S. H., observer.
9. A star (9 mag.) 1′.5 south of moon's center at $21^h\ 33^m$ sid. t., disappeared at $7^h\ 56^m\ 48^s.10$. Satisfactory observation. E. S. H., observer.

October 18, 1882.

10. Yarnall 8087 disappeared at $6^h\ 30^m\ 53^s.96$. Good observation taken between thick clouds, which prevented the observation of Yarnall 8088. E. S. H., observer.
11. A star (6 mag.) about 10′ ± south of moon's N. L., disappeared at $9^h\ 8^m\ 53.90^s$. The observation taken through thick clouds, and uncertain by about $\pm 0^s.3$. E. S. H., observer.

1882, October 19.

12. A star (9 mag.) about 6′.5 north of the moon's south limb disappeared at $7^h\ 7^m\ 38^s.57$. Good observation. E. S. H., observer.

1882, November 15. Hazy sky.

13. A star (9 mag.) 10′.5 south of moon's N. L., disappeared in the glare at $5^h\ 18^m\ 53^s$. Probably this time is not so much as 1^s wrong. E. S. H., observer.
14. A star (9 mag.) 5′.8 south of moon's N. L., disappeared at $5^h\ 27^m\ 52^s.59$. This time uncertain by about $0^s.3$. E. S. H., observer.

15. A star (9 mag.) disappeared 5′ south of moon's N. L., at $5^h\ 42^m\ 16^s.22$ This time is uncertain about $0^s.5$. E. S. H., observer.
16. A star (8.5 mag.) disappeared exactly at moon's north point at $6^h\ 0^m\ 11^s.68$. Good observation. E. S. H., observer.
17. A star (A Oe_2 19912–3–4) disappeared at $6^h\ 22^m\ 42^s.58$. The time is uncertain by $0^s.2$. No more stars could be observed on account of a dense mist. E. S. H., observer.

1882, December 14.

18. A star (9 mag.?) disappeared at $7^h\ 29^m\ 51^s.62$. The star was 3′ south of moon's N. L., and is probably Lamont 3606. E. S. H., observer.
19. A star (8 mag.) = Ll. 41526–7 about $10\frac{1}{2}'$ north of moon's S. L., disappeared at $7^h\ 55^m\ 0^s.09$. Good observation. E. S. H., observer.

1882, December 15.

20. A star (Ll. 43386) disappeared at $7^h\ 35^m\ 56^s.19$. C. M. C., observer.
21. A star (Ll. 43400) disappeared at $8^h\ 46^m\ 9^s.26$. Good observation. C. M. C., observer.

1883, January 13.

22. 22 Piscium disappeared at $8^h\ 36^m\ 52^s.49$. Good observation. E. S. H., observer.

No more occultations could be observed before my departure from Madison on the expedition to observe the total eclipse.

1883, April 11.

23. D M., 19°, 1023, disappeared at $9^h\ 36^m\ 21^s.2$. G. C. C., observer.
24. A star, $10\frac{1}{2}$ mag., about 40′ from the N. cusp., disappeared at $9^h\ 37^m\ 9^s.3$. G. C. C., observer.
25. A star, 10 mag., about 40° from the N. cusp., disappeared at $9^h\ 38^m\ 7^s.7$. G. C. C., observer.
26. D M. 19°, 1024, disappeared at $9^h\ 50^m\ 18^s.1$. G. C. C., observer.

27. D M. 18°, 921 (?) disappeared at 10^{h} 2^{m} $26^{s}.9$. G. C. C., observer.
28. 127 *Tauri*, disappeared at 10^{h} 9^{m} $56^{s}.1$. G. C. C., observer.

1883, April 13.

29. A star (6 mag.) disappeared at 9^{h} 0^{m} $3^{s}.3$. G. C. C., observer.
30. D M. 16°, 1506, disappeared at 9^{h} 18^{m} $21^{s}.0$. G. C. C., observer.
31. 68 *Geminorum* = No. 377 NEWCOMB's standard stars, disappeared at 9^{h} 57^{m} $39^{s}.1$. G. C. C., observer.

1883, May 11.

32. D M. 14°, 1827, disappeared at 9^{h} 11^{m} $41^{s}.9$. Observation only moderately good. Star was lost at moon's limb. G. C. C., observer.
33. D M. 14°, 1828, disappeared at 9^{h} 15^{m} $24^{s}.2$. Good observation. G. C. C., observer.
34. D. M. 14°, 1829, disappeared at 9^{h} 26^{m} $32^{s}.9$. Good observation. G. C. C. observer.

1883, July 13.

35. Ll. 26702 disappeared at 9^{h} 3^{m} $9^{s}.3$. G. C. C., observer.
36. Ll. 26706—7 disappeared at 9^{h} 19^{m} $32^{s}.1$. G. G. C., observer.

1883, September 12.

37. A star (probably LAMONT, 1100) 9 mag., disappeared at 8^{h} 8^{m} $55^{s}.8$. G. C. C., observer.

1883, October 10.

38. W_1 B, 20,^{h} 844, disappeared at 8^{h} 42^{m} $44^{s}.8$- E. S. H., observer.

1883, November 10.

39. 21 Piscium disappeared at 6^{h} 21^{m} $43^{s}.5$. J. T., observer.
40. W_2 B; 23^{h},922? disappeared at 7^{h} 7^{m} $28^{s}.7$. J. T., observer.

X. — THE STAR-GAUGES OF SIR WILLIAM HERSCHEL, REDUCED TO 1860.0. FIRST SERIES, (NOS. 1–683.)

In this and the following sections I have collected a series of star-gauges and of counts from the celestial charts of DR. PETERS, HERR PALISA and others, for comparison with a series of star-gauges which have been begun at the Washburn Observatory, with the 15 inch equatorial.

Our gauges are made with the full aperture, and with an eye-piece magnifying 195 diameters which has been fitted with a diaphragm containing a square hole 10′ on each side.

The gauges of SIR WILLIAM HERSCHEL were made with his twenty foot reflector and with an eye-piece magnifying 157 times, whose circular field had a diameter of 15′ 4″.

Besides the 683 published gauges of HERSCHEL, 405 unpublished gauges are given in Part XI. or 1088 in all.

The gauges of SIR JOHN HERSCHEL with the same instrument are given in the *Results of Astronomical Observations at the Cape of Good Hope.* The celestial charts of DR. PETERS, and his revision and completion of CHACORNAC'S Paris charts (unpublished) were made with the SPENCER equatorial of Hamilton College Observatory, 13½ inches in aperture. PROF. Watson's charts (ms) were made with the FITZ equatorial of 12½ inches aperture, belonging to the Ann Arbor Observatory. HERR PALISA'S charts (ms) were made with the 6 (French) inch equatorial at Pola, and the 12 inch ALVAN CLARK equatorial of Vienna.

Besides these series, I know of only one other published set of observed star-gauges. These are by M. CELORIA, in the publications of the Milan Observatory, No. XIII. It would be of extreme interest to this branch of astronomy if the counts of stars in each square degree of the *Durchmusterung,* which were made at the observatory at Bonn, (See *Bonner Beobachtungen* Bd. V. sec. 3) could be printed.

The present volume contains then,

683	gauges	by W. HERSCHEL	(published).
405	"	" "	(unpublished).
500	"	" C. H. F. PETERS	(published).
983	"	" C. H. F. PETERS, J. C. WATSON and J. CHACORNAC	(unpublished).
781	"	" J. PALISA	(unpublished).
3352	"	all reduced to 1860.0	

I am now discussing these various gauges by a graphical process, and they promise to lead to very interesting results, especially when they are supplemented by other star-gauges covering the same ground and made by a larger instrument. If at the same time the total amount of light in each field could be quickly measured by a tolerably accurate photometric process, the data thus derived would be most important. One of the most obvious deductions from a series of star-gauges of a given region by telescopes of different apertures, is the determination of the number of stars of each (nominal) magnitude which exist in the region. For the difference of the counts made by two telescopes which can just see stars of the mth and nth magnitudes respectively will give the number of stars of the $(m—n)$th magnitude, and so on.

If these differences, m-n, n-o, o-p, etc., be platted separately, the eye can determine whether each group is affected by a clustering power peculiar to itself, or whether the same cause is apparent in the configurations of the various groups. The question of how many nominal magnitudes correspond to stars which really belong to the same system and are at the same distance, appears to be capable of solution by this process; and other cognate questions will have some light thrown upon them.

This first series of the gauges of Sir WILLIAM HERSCHEL was published in the *Philosophical Transactions* for 1785, page 220. The positions were given for 1690.0. These positions have been brought up to 1860 so as to be true to the nearest 1^s and $1'$. The computation has been made by Mr. COMSTOCK and portions of it in duplicate by myself.

REDUCTION OF STAR-GAUGES.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
1	0 10 24	+12 10	9.9	10	
2	13 41	+25 21	20.0	10	
3	16 39	+16 44	11.3	10	Most of the stars extremely small.
4	17 17	+41 50	60.0	1	
5	18 28	—22 20	4.1	10	
6	21 27	—22 20	3.2	10	
7	25 39	+23 12	11.9	10	
8	30 23	—22 21	3.9	10	
9	3 4	+ 3 46	5.9	10	
10	37 39	+44 2	60.0	1	
11	40 53	+44 2	40.0	1	
12	42 32	+25 24	20.4	10	
13	43 29	+34 18	20.0	1	
14	44 31	+35 18	24.0	1	
15	45 31	+14 24	11.3	10	
16	48 57	+12 13	8.1	10	
17	49 51	+42 13	60.0	½	
18	53 6	+ 3 46	7.6	10	
19	55 23	+21 5	11.0	10	
20	55 38	+25 24	13.0	10	
21	57 56	+32 9	40.0	1	
22	0 58 5	+32 43	17.0	1	
23	1 2 24	+23 14	9.8	10	A little hazy
24	3 19	+45 18	73.0	1	
25	1 3 8	+15 39	13.0	1	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
26	1 4 10	+17 39	14.0	1	
27	5 3	+16 55	15.0	1	
28	6 9	−22 22	3.8	10	
29	8 10	+16 30	14.0	1	
30	9 16	+16 39	11.1	10	
31	10 11	+16 50	11.2	10	
32	9 36	−20 5	5.2	10	Very clear for this altitude.
33	12 26	+38 55	28.1	10	Most of the stars very small
34	12 6	−22 23	2.8	10	
35	12 52	− 3 58	7.5	10	
36	13 46	+25 22	11.0	10	
37	14 52	−12 23	9.2	10	
38	17 20	+45 31	58.0	1	
39	21 28	+32 17	20.0	1	
40	22 14	+30 35	13.0	1	
41	21 40	− 3 56	6.3	10	
42	25 43	+42 14	30.0	1	
43	28 15	+42 14	58.0	1	
44	33 19	+42 13	44.0	1	
45	36 53	+25 11	12.9	10	
46	40 8	+ 3 45	5.8	10	
47	40 39	− 3 58	7.3	10	
48	41 36	− 9 16	6.4	10	
49	42 9	− 1 43	7.1	10	
50	44 30	+30 44	17.0	1	
51	53 0	+25 10	14.4	10	
52	54 45	+21 8	7.1	10	
53	1 56 28	− 9 22	4.9	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
54	2 3 34	+14 22	12.1	10	
55	8 40	+28 54	15.0	10	
56	13 17	+ 3 43	6.4	10	
57	13 43	+12 10	9.3	10	
58	15 44	— 4 8	7.8	10	
59	16 58	+ 7 45	7.3	10	
60	18 24	-- 9 24	4.3	10	
61	21 10	+25 3	14.8	10	
62	24 20	—20 7	4.2	10	
63	28 42	+14 23	9.9	10	
64	33 15	+45 15	82.0	1	
65	33 7	+30 30	14.0	1	
66	31 4	—22 22	4.2	10	
67	34 13	+32 16	15.0	1	
68	35 17	—24 36	3.0	10	Too low for great accuracy.
69	38 31	— 4 11	6.0	10	
70	40 41	+14 23	13.8	10	
71	44 4	+ 3 42	5.6	10	
72	46 30	— 4 12	6.6	10	
73	52 9	+28 53	14.8	10	
74	56 58	+16 39	11.1	10	Most of the stars very small
75	57 57	— 2 13	9.0	10	
76	57 14	—20 13	6.1	10	
77	2 58 29	— 4 14	6.8	10	
78	3 4 15	+14 19	9.2	10	
79	9 4	+ 9 30	6.1	10	
80	11 9	+12 3	4.1	10	
81	3 11 5	+ 9 30	5.1	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
82	3 14 10	+12 2	3.5	10	
83	18 33	— 9 24	6.8	10	
84	21 30	+31 9	7.0	5	In part of the heavens which looks pretty free of stars to the naked eye.
85	23 30	+31 8	6.1	10	
86	25 30	+31 8	9.4	10	
87	32 2	+ 7 35	10.3	10	
88	31 55	— 2 13	10.1	10	
89	41 14	+43 59	55.0	1	About 15 stars generally in the field.
90	45 22	+28 32	15.0	1	
91	43 22	— 9 30	7.4	10	
92	43 25	—22 30	4.9	10	
93	54 35	+44 22	54.0	1	
94	3 56 25	— 9 28	8.1	10	
95	4 4 50	+16 27	11.0	10	
96	9 57	— 2 20	13.8	10	
97	15 26	+ 7 30	13.4	10	
98	15 40	—24 29	4.2	10	And many extremely small suspected.
99	22 40	+21 52	15.3	10	
100	23 51	—22 20	6.2	10	
101	33 49	—22 23	8.8	10	
102	37 7	+19 41	25.0	1	
103	38 40	+20 21	17.0	1	
104	39 7	+20 58	30.0	1	
105	38 20	— 9 28	9.7	10	
106	41 29	+22 48	15.6	10	
107	42 33	+21 19	36.0	1	
108	4 40 35	—24 34	8.1	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
109	4 51 10	+ 3 51	19.9	10	
110	5 3 11	+17 17	56.0	1	
111	6 53	+ 6 53	38.0	1	
112	7 48	+ 5 39	35.0	1	
113	11 22	+20 51	34.0	1	
114	12 53	+ 6 44	17.7	6	
115	20 58	+20 50	74.0	1	
116	19 39	− 6 25	24.0	1	
117	25 40	− 6 5	8.9	8	
118	27 19	+ 9 24	30.0	1	Not exactly gauged.
119	29 38	− 2 43	19.1	10	
120	34 34	+24 4	36.0	1	
121	37 12	+21 16	58.0	1	
122	35 6	−20 32	17.7	10	
123	42 42	+13 56	65.0	1	
124	43 33	+23 40	86.0	1	
125	40 14	−24 53	13.5	10	
126	44 47	+19 33	50.0	1	
127	47 12	+28 5	20 to 30		Not very exact.
128	46 49	+15 39	140.0	½	
129	48 49	+19 57	73.0	1	
130	51 32	+23 21	60.0	1	
131	50 48	−26 40	11.5	10	
132	54 38	+ 6 33	50.0	1	
133	54 42	−22 31	19.3	10	
134	59 13	+28 1	30.0	1	Not very exact.
135	5 57 15	− 2 49	22.4	5	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	′ ″			
136	5 58 22	+ 9 57	50.0	1	
137	6 0 43	— 3 12	44.0	1	
138	1 38	+ 6 32	60.0	1	
139	2 22	+ 9 56	110.0	1	
140	3 34	— 2 55	57.0	1	
141	6 42	+19 34	73.0	1	
142	6 22	+ 9 56	60.0	1	
143	4 54	—20 33	19.6	10	
144	7 38	+ 1 24	90.0	1	
145	8 38	+ 6 30	80.0	1	
146	9 18	+ 3 21	24.1	10	
147	10 22	+ 9 54	70.0	1	
148	13 22	+ 9 54	90.0	1	
149	15 21	+22 41	120.0	¼	Very unequally scattered.
150	14 31	— 6 18	52.0	1	
151	15 38	+ 6 28	80.0	1	
152	15 51	+ 9 53	70.0	1	
153	15 13	— 1 47	54.0	1	Like many such fields.
154	16 51	+21 34	56.0	1	
155	18 21	+ 9 52	74.0	1	
156	16 37	—23 38	26.0	1	
157	21 42	+27 56	30–40	1	Between (30–40.)
158	20 21	+ 9 52	63.0	1	The least number I could find
159	18 44	—22 8	33.0	1	
160	20 18	— 0 18	——	1	
161	24 16	+21 45	178.0	¼	
162	6 23 19	— 0 19	77.0	1	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
163	6 28 27	+27 55	50.0	1	
164	26 31	— 6 17	38.0	1	Very unequally scattered.
165	27 40	— 4 4	72.0	1	
166	33 13	—25 6	15.9	10	
167	35 39	— 4 43	132.0	½	
168	37 34	+19 30	50.0	1	
169	38 42	—25 48	40.0	1	
170	43 16	— 2 34	94.0	1	
171	44 20	+10 46	50.0	1	Generally about fifty stars.
172	44 22	— 5 5	62.0	1	Twilight.
173	46 56	+14 45	70.0	1	Generally about 70.
174	47 14	— 9 17	50.0	1	
175	46 50	—26 53	13.3	10	
176	52 49	+10 44	67.0	1	
177	52 29	—10 41	67.0	1	
178	57 57	+ 2 27	120.0	½	
179	59 0	+12 17	50.0	1	Many fields like this.
180	58 16	— 2 45	120.0	½	
181	59 16	— 8 46	78.0	1	
182	6 58 52	—26 34	48.0	1	
183	7 1 49	+10 42	60.0	1	About 60 stars.
184	1 14	— 3 12	98.0	1	
185	1 26	—21 24	45.0	1	
186	5 11	—10 15	34.0	1	
187	5 46	— 9 4	83.0	1	
188	5 49	—23 3	81.0	1	
189	7 9 49	+10 40	70.0	1	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
190	7 12 34	— 2 19	102.0	1	
191	12 35	— 9 15	70.0	1	
192	12 27	—21 27	70.0	1	
193	15 22	—22 32	62.0	1	
194	20 11	—10 23	118.0	½	
195	23 49	— 8 31	112.0	½	
196	27 35	— 2 11	58.0	1	
197	29 23	+10 41	48.0	1	
198	32 28	—21 42	168.0	¼	One of the richest fields.
199	35 23	—22 56	204.0	¼	A field like the rest.
200	40 10	—25 51	86.0	1	
201	7 48 22	—23 51	108.0	½	
202	8 1 47	+ 2 54	28.3	10	
203	8 30	—21 44	80.0	1	
204	10 21	—24 0	60.0	1	
205	14 45	—10 35	40.0	1	
206	15 49	— 9 33	45.0	1	
207	19 18	— 9 56	24.2	10	
208	19 58	—22 46	52.0	1	
209	29 33	—22 3	35.0	1	
210	38 33	—22 36	33.0	1	
211	39 53	—22 42	30.0	1	
212	42 33	—22 53	24.0	1	
213	42 47	—21 55	20.0	1	
214	47 38	—21 48	22.0	1	
215	52 32	—24 0	13.0	1	
216	8 55 16	— 2 4	20.3	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
217	8 55 37	−23 1	16.2	10	
218	9 7 16	+23 0	8.3	10	
219	14 15	− 2 3	13.8	10	
220	17 34	−25 59	14.0	10	
221	27 30	−23 7	15.8	10	
222	28 58	− 9 56	11.1	10	
223	29 44	+ 1 9	11.5	10	
224	42 51	−23 9	13.0	10	
225	45 44	−26 3	10.1	10	
226	46 48	− 1 9	7.9	10	
227	51 5	+ 2 57	7.7	10	
228	9 53 40	−23 8	13.2	10	Strong twilight.
229	10 7 53	−26 6	9.1	10	
230	25 2	+ 1 1	7.2	10	
231	28 11	− 2 6	6.5	10	
232	33 52	+ 1 0	4.9	10	
233	10 34 54	+ 7 27	5.6	7	
234	11 12 53	+ 7 27	5.3	6	
235	16 17	− 2 9	5.6	10	
236	18 26	−26 19	6.5	10	Twilight.
237	25 39	+ 7 26	3.1	8	
238	11 29 18	− 2 13	4.9	10	
239	12 2 29	+ 7 24	6.0	5	
240	13 46	+10 6	2.2	13	
241	39 16	+10 1	3.4	11	
242	55 26	+ 7 24	4.6	13	
243	12 56 52	+10 0	3.9	13	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
244	13 2 39	—12 40	9.3	10	Twilight.
245	6 1	—10 51	8.1	10	Pretty strong daylight.
246	9 46	+10 1	3.8	12	
247	26 26	—12 39	8.6	10	Twilight.
248	31 46	—10 54	8.4	10	Some daylight.
249	36 58	—12 38	11.3	10	
250	39 30	+13 13	5.6	1	Generally 5–6
251	48 1	—15 19	8.5	10	
252	13 57 50	—10 51	9.2	10	Strong twilight.
253	14 0 32	—12 35	10.0	10	
254	3 17	+30 59	7.4	10	Twilight.
255	7 6	—15 17	12.3	10	Most very small.
256	18 54	—10 49	11.2	10	
257	23 30	—23 51	9.7	10	
258	24 7	—12 32	8.8	10	All sizes.
259	33 12	+ 7 21	2.7	6	
260	38 53	—10 50	13.3	10	
261	37 47	+23 12	8.8	10	
262	38 28	+ 8 37	3.5	13	
263	40 36	+31 9	8.9	10	Chiefly small.
264	43 37	—23 48	10.3	10	
265	49 11	—12 28	14.0	10	All sizes.
266	48 9	+24 30	6.4	10	
267	54 5	—25 37	10.3	10	
268	59 42	—23 46	12.8	10	
269	14 58 20	+31 8	9.2	10	
270	15 0 13	+28 38	4.4	10	Struve's aurora.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
271	15 0 41	+23 4	9.0	10	Chiefly large
272	3 4	+24 32	6.6	10	Most very small.
273	9 10	—25 34	8.8	10	
274	10 0	+26 33	8.3	10	
275	10 37	+23 6	9.5	10	
276	12 1	+24 34	5.0	10	
277	18 32	—23 39	14.1	10	
278	17 37	— 3 44	9.4	12	
279	20 57	+26 34	8.9	10	
280	22 40	+31 6	10.0	10	Twilight.
281	26 52	+28 44	4.9	10	Aurora bright so as to aff'ct gauge.
282	27 59	+13 32	9.5	4	
283	29 52	— 3 41	10.9	12	
284	34 24	+ 7 32	11.0	5	
285	38 3	—10 26	13.1	10	
286	36 30	+23 12	10.6	10	All sizes.
287	36 35	+31 8	8.9	10	Twilight.
288	39 57	+13 35	6.0	6	
289	43 48	—22 6	12.8	10	
290	42 57	+13 36	6.5	6	
291	48 58	+31 14	13.1	10	Twilight
292	52 23	—27 28	18.6	10	
293	53 0	—24 19	32.5	2	Stars too small for the gauge.
294	55 23	— 3 36	10.8	12	
295	58 42	—23 31	17.1	10	
296	55 51	+26 25	12.4	10	
297	15 59 51	—22 2	18.1	10	Very low.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
298	16 0 33	−25 25	9.2	10	
299	7 26	−27 25	7.2	10	
300	6 43	+31 18	12.2	10	
301	10 27	−27 24	6.1	10	
302	10 28	−25 25	1.6	10	
303	13 28	−25 24	2.0	10	
304	11 52	+13 50	13.0	6	
305	14 27	−23 33	0.5	10	Perfectly clear.
306	11 47	+26 29	12.0	10	Most small.
307	14 10	−10 24	14.6	10	Moon and twilight.
308	16 37	−23 31	0.7	10	Perfectly clear.
309	14 26	+23 18	13.3	10	
310	18 24	−25 27	3.8	6	
311	17 5	− 3 35	12.2	12	
312	18 41	−27 14	11.6	10	
313	19 28	−23 30	1.1	10	Perfectly clear.
314	21 38	−23 30	1.4	10	Perfectly clear
315	23 38	−23 29	1.8	10	
316	20 29	+31 11	14.2	10	Most small.
317	21 41	+26 28	15.1	10	Most small.
318	23 46	+ 8 55	9.7	12	All sizes.
319	27 39	−23 28	4.7	10	
320	29 4	+ 7 39	13.8	6	
321	30 42	+15 54	24.0	1	
322	33 39	−23 27	13.6	10	
323	33 5	− 3 32	13.6	12	Require attention to be seen.
324	16 33 15	+ 8 57	14.6	13	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
325	16 34 51	+21 15	21.6	10	Twilight.
326	39 45	—27 10	50.4	10	
327	38 45	+ 8 58	34.0	1	
328	38 22	+23 24	18.4	10	Strong twilight.
329	42 41	—23 25	20.3	10	Most small.
330	39 24	+31 15	15.6	10	Most small.
331	42 37	+26 33	16.5	10	Most small.
332	44 43	— 3 35	18.6	12	All sizes.
333	45 21	+23 25	20.1	10	Strong twilight.
334	48 37	—18 17	19.9	10	Ditto.
335	51 6	—23 33	41.1	8	
336	16 52 49	+21 19	19.0	4	Hazy.
337	17 1 38	—18 14	29.8	10	
338	16 59 30	+23 18	16.6	10	Daylight pretty strong
339	17 2 33	+26 37	26.6	10	Strong twilight.
340	8 0	+31 35	18.8	10	Strong daylight.
341	10 28	+23 20	35.0	1	Daylight too strong.
342	15 52	— 8 15	13.7	10	More suspected.
343	20 5	—27 7	7.6	10	
344	16 47	+21 25	32.3	10	
345	18 15	+23 22	38.0	1	Daylight pretty strong
346	20 15	+26 28	32.8	10	Daylight pretty strong
347	27 47	—21 57	15.3	10	Moon and daylight pretty strong.
348	35 3	—18 14	23.0	10	
349	38 5	—26 56	25.0	1	
350	16 35 45	+21 30	42.2	5	Twilight.

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
351	17 41 5	−26 55	42.0	1	
352	44 5	−26 55	52.0	1	Daylight very strong.
353	43 52	− 8 44	18.5	10	Twilight.
354	50 27	−30 5	84.0	1	Most large.
355	51 8	−24 57	77.0	1	Daylight.
356	52 6	−26 52	82.0	1	Daylight.
357	53 28	−15 7	80.0	1	Flying clouds.
358	54 38	+28 39	25.6	5	Most large.
359	56 15	+33 42	27.2	10	Twilight.
360	18 0 4	−18 7	59.0	1	Like the rest
361	2 4	−18 7	118.0	1	Many such fields.
362	18 2 14	− 8 45	7.6	10	
363	17 59 12	+27 46	40.0	1	Most large.
364	17 59 54	+21 39	54.0	1	Daylight.
365	18 5 3	−18 6	232.	½	
366	5 2	−16 7	112.0	1	Many such.
367	5 56	−22 55	112.0	½	
368	4 3	+29 32	38.0	1	Most large.
369	8 13	−13 24	35.0	1	
370	9 29	−28 57	64.0	1	
371	9 55	−32 17	17.0	1	
372	8 57	−18 8	320.0	½	
373	8 59	−14 24	68.0	1	
374	11 18	−32 11	27.0	1	
375	14 46	−30 41	19.0	1	
376	14 34	− 8 46	65.	1	
377	18 15 21	− 0 34	9.4	10	Too soon for gazing

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
378	18 13 47	+27 48	40.0	1	Most large.
379	13 15	+33 46	38.2	5	
380	17 13	—13 23	88.0	3	
381	21 5	—30 55	20.0	1	
382	17 29	+28 55	78.0	1	Chiefly large.
383	21 28	—14 3	170.0	½	
384	23 16	—14 13	238.0	½	
385	22 46	— 3 8	20.0	7	
386	20 58	+33 44	48.0	1	
387	24 20	— 2 38	3.4	7	
388	25 44	— 2 37	8.9	7	
389	27 32	— 2 37	13.8	7	
390	29 9	—12 29	9.5	2	
391	29 42	—13 13	19.0	1	
392	30 38	— 2 37	25.8	6	
393	30 39	—13 50	22.0	1	
394	30 57	— 0 36	8.6	10	
395	31 7	—13 30	24.0	1	
396	28 46	+27 59	48.0	1	Large and small.
397	28 15	+33 50	39.6	5	
398	31 57	—14 0	14.0	1	
399	32 14	—13 39	30.0	1	
400	34 31	—25 4	35.0	1	
401	34 6	—19 29	35.0	1	
402	33 39	—12 25	30.0	1	
403	34 4	— 2 53	88.0	1	
404	18 34 19	—13 33	25.0	1	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
405	18 35 9	—12 28	39.0	1	
406	35 31	— 7 56	111.0	1	
407	35 1	—13 50	60.0	1	
408	35 59	— 7 36	250.0	1	
409	37 58	—30 51	30.0	1	
410	38 50	—30 37	32.0	1	
411	37 40	—12 44	13.0	1	Extremely small.
412	36 56	— 1 37	39.	1	Most small.
413	37 59	—13 2	20.0	1	Extremely small.
414	39 42	—32 18	12.0	1	
415	39 0	—13 16	20.0	1	Extremely small.
416	38 59	— 7 42	150.0	1	
417	40 48	—31 31	24.0	1	
418	36 51	+32 50	62.0	1	
419	40 2	— 2 34	13.7	7	
420	41 9	—18 45	74.0	1	Twilight.
421	40 48	—13 11	112.0	1	All sizes.
422	40 30	— 7 45	188.0	½	Many more suspected.
423	42 13	+27 34	76.0	1	Large and small.
424	42 49	—31 31	19.3	10	
425	43 1	—18 35	88.0	1	Twilight.
426	42 44	—13 45	146.0	½	
427	43 20	— 8 25	130.0	1	
428	42 15	+18 16	78.0	1	
429	41 34	+29 28	80.0	1	Large and small.
430	46 38	—20 3	83.0	1	Twilight.
431	18 45 22	— 1 28	176.0	¼	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
432	18 44 18	+17 41	224.0	½	
433	46 29	— 3 19	5.0	1	
434	47 39	—14 4	118.0	½	
435	48 37	— 3 42	116.0	¼	
436	49 20	— 2 37	10.0	1	
437	48 57	+18 22	236.0	¼	
438	50 10	— 1 27	156.0	¼	
439	53 47	—31 28	15.2	10	Very clear.
440	50 47	+18 3	368.0	¼	
441	54 19	—29 10	21.0	1	
442	54 48	—22 32	53.0	1	
443	51 10	+29 37	84.0	1	All sizes.
444	56 18	— 1 2	328.0	¼	
445	58 7	—20 0	83.0		
446	56 55	+29 17	136.0	½	Many small.
447	18 57 25	+32 47	84.0	1	
448	19 1 27	—18 13	36.8	5	Strong twilight.
449	3 16	—25 17	26.2	5	
450	0 24	+32 56	93.0	1	
451	2 54	— 1 0	328.0	¼	
452	4 33	—14 9	180.0	½	
453	5 0	—18 27	80.0	1	
454	2 3	+27 43	206.0	½	
455	7 54	— 1 0	328.0	¼	
456	6 59	+ 7 38	40.0	1	Too soon.
457	8 31	+18 35	75.0	1	
458	19 7 53	+33 28	127.0	1	Moon.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
459	19 10 12	+15 23	204.0	¼	Twilight.
460	12 10	—13 0	160.0	½	
461	13 44	—31 23	14.1	10	
462	9 49	+34 20	146.0	½	Moon.
463	13 16	+29 8	196.0	½	Many small besides.
464	13 55	+33 21	130.0	½	Moon.
465	14 18	+32 18	116.0	½	
466	17 27	— 1 51	120.0	½	
467	19 32	—18 44	60.0	1	
468	16 1	+33 26	130.0	1	Moon.
469	20 44	+14 57	58.0	1	
470	20 28	+30 19	256.0	¼	
471	20 27	+30 49	158.0	½	
472	21 35	+18 3	60.0	1	
473	20 48	+28 57	279.0	⅛	Too cr'wded for accuracy.
474	24 28	—13 18	64.0	1	Changed focus.
475	21 54	+34 53	160.0	1	Moon.
476	23 32	+29 36	296.0	¼	
477	24 37	+16 56	56.0	1	
478	27 35	—17 53	50.0	1	
479	26 20	+12 10	196.0	¼	
480	25 13	+28 58	279.0	½	
481	26 16	+33 5	180.0	½	
482	29 47	—17 53	55.0	1	
483	27 34	+28 45	384.0	¼	
484	29 0	+11 33	472.0	½	
485	19 27 49	+35 3	208.0	½	Moon.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
486	19 29 18	+27 51	320.0	¼	
487	30 59	+33 32	224.0	¼	
488	34 24	—14 3	36.0	1	
489	31 33	+29 38	296.9	¼	
490	35 7	—23 30	18.3	10	
491	31 30	+33 12	190.0	½	Moon.
492	32 17	+26 3	280.0	½	
493	32 0	+30 45	340.0	½	
494	35 10	—13 29	55.0	1	Too small and too crowded to be certain.
495	35 12	+17 48	424.0	¼	
496	34 29	+29 14	240.0	⅓	
497	37 32	—13 8	45.0	1	
498	34 31	+33 33	288.0	¼	
499	35 30	+30 56	344.0	¼	
500	35 16	+33 35	186.0	½	Moon very bright.
501	36 51	+25 12	34.0	1	
502	38 20	+15 49	588.0	¼	
503	36 51	+35 29	312.0	¼	
504	40 24	—2 12	62.2	5	
505	42 4	—19 22	23.8	10	
506	39 9	+27 47	296.0	¼	
507	39 23	+34 49	212.0	½	
508	42 37	—12 49	50.0	1	
509	40 1	+29 15	240.0	⅓	
510	39 57	+31 24	232.0	¼	
511	45 11	—25 21	14.1	10	
512	19 42 32	+27 4	256.0	¼	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
513	19 42 22	+35 26	384.0	¼	
514	46 4	−12 8	68.0	1	
515	48 35	+29 48	296.0	¼	
516	47 30	+27 24	296.0	¼	
517	47 25	+31 12	192.0	¼	
518	48 33	+15 51	588.0	¼	
519	50 14	+17 11	352.0	¼	
520	50 1	+33 2	130.0	½	
521	51 0	+25 58	124.0	½	Most large.
522	53 34	+12 27	140.0	½	Faint moon
523	55 5	−12 38	50.0	1	
524	54 1	+17 12	352.0	¼	
525	57 9	−25 18	12.8	10	Twilight.
526	53 57	+29 51	312.0	¼	
527	57 11	−19 20	20 9	10	
528	53 56	+32 48	312.0	¼	Very unequally scattered.
529	55 38	+33 13	268.0	¼	
530	56 18	+33 35	120.0	½	Moon.
531	58 55	− 2 13	39.2	5	Most small.
532	58 34	+27 50	51.0	1	
533	58 53	+33 12	220.0	½	Moon.
534	19 59 50	+29 51	80.0	1	
535	20 0 31	+26 47	52.0	½	
536	0 2	+35 28	306.0	¼	
537	4 31	−31 12	7.7	10	
538	0 23	+35 15	160.0	½	Moon.
539	20 2 12	+12 24	120.0	½	Moon.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
540	20 1 8	+30 30	136.0	¼	
541	2 7	+27 47	48.0	1	
542	3 10	+28 44	112.0	½	
543	2 57	+33 11	192.0	¼	
544	4 20	+27 54	45.0	1	
545	4 21	+31 59	104.0	½	
546	6 49	+27 51	41.0	1	
547	8 24	+11 26	56.0	1	Strong moon.
548	6 49	+35 17	184.0	½	Moon.
549	7 16	+29 56	80.0	1	Most extremely small.
550	11 5	—25 15	12.2	10	Twilight.
551	9 44	+10 55	68.0	1	Moon.
552	12 0	+33 56	46.0	1	Moon.
553	13 9	+11 34	280.0	¼	
554	16 4	—16 57	22.6	10	
555	13 44	+27 58	75.0	1	Very small.
556	15 1	+34 3	47.4	5	Moon.
557	16 10	+17 34	280.0	¼	
558	18 18	—13 7	38.0	1	
559	18 55	—19 10	24.2	5	
560	19 16	—12 17	31.0	1	
561	19 6	+32 17	76.0	½	
562	25 16	+14 20	184.0	¼	Some Twilight.
563	29 0	—25 12	10.6	10	Twilight.
564	27 59	+29 6	88·0	1	
565	30 16	+19 5	104.0	½	Hazy.
566	20 29 37	+34 6	66.0	1	Moon.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
567	20 32 23	−12 53	20.0	1	
568	34 59	−25 11	9.3	10	Twilight.
569	35 22	−12 52	22.8	10	
570	33 25	+23 7	248.0	¼	
571	34 51	− 2 10	30.8	5	
572	36 31	−19 3	16.7	10	Not clear.
573	37 20	−31 5	7.7	10	Hazy.
574	36 33	− 5 33	39.0	1	Most small.
575	44 56	−25 8	9.5	10	Moon.
576	42 59	+29 16	142.0	½	
577	44 12	+32 8	108.0	½	
578	46 36	− 6 30	26.6	10	
579	46 50	− 2 8	28.2	5	
580	47 9	+24 0	78.0	½	
581	47 8	+34 16	192.0	¼	
582	48 43	+22 43	108.0	½	
583	49 50	+16 4	116.0	½	
584	50 10	+28 23	112.0	½	
585	50 42	+20 8	76.0	1	
586	50 11	+35 50	260.0	¼	Same size.
587	52 39	+20 31	80.0	1	
588	54 20	+29 52	120.0	½	
589	57 50	− 2 6	27.0	5	
590	20 56 4	+33 27	248.0	½	Same size.
591	21 0 19	−12 48	17.2	3	
592	20 58 59	+22 9	70.0	1	
593	21 2 49	−12 47	47.0	5	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m s.	° ′			
594	21 3 34	—17 7	10.3	10	
595	6 18	—12 46	14.9	10	Most extremely small.
596	5 9	+29 15	64.0	1	Twilight.
597	7 50	— 2 4	21.4	5	
598	10 6	— 6 3	40.0	1	Most small.
599	11 3	+24 2	80.0	½	
600	11 47	+17 32	55.0	1	
601	13 56	+21 18	40.0	1	Hazy.
602	16 13	—12 51	11.1	10	
603	17 22	—19 3	12.8	10	
604	15 29	+25 44	110.0	½	
605	16 44	+29 6	75.0	1	Twilight.
606	17 29	+30 3	70.0	1	Twilight.
607	19 13	+17 24	50.0	1	
608	20 39	— 5 31	25.0	1	
609	20 49	— 2 2	16.4	5	
610	24 37	—19 13	15.3	10	
611	23 57	+31 36	76.0	½	
612	26 2	+33 23	50.0	1	
613	29 16	— 5 59	24.0	1	
614	30 26	—17 5	8.1	10	
615	30 21	+14 11	30.0	5	
616	34 19	— 2 0	8.0	5	
617	37 27	+ 7 34	21.6	5	
618	39 13	+11 48	18.9	10	
619	39 25	+33 32	25.0	1	
620	21 41 48	— 1 58	15.4	5	Strong twilight.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
621	21 43 53	− 6 31	13.6	10	
622	44 21	+24 57	42.0	1	
623	46 3	+25 8	60.0	1	
624	48 50	− 5 30	18.0	1	
625	49 16	+32 5	44.0	1	
626	52 48	−19 8	11.5	10	
627	52 33	+31 8	52.0	1	
628	55 52	+31 18	29.0	1	
629	21 59 22	+31 52	61.0	1	
630	22 0 51	− 6 29	11.5	10	
631	3 44	−19 6	12.8	10	
632	5 24	+31 12	60.0	½	
633	6 16	+15 42	33.0	1	
634	5 53	+31 43	40.0	½	
635	6 16	+32 15	32.6	5	
636	6 21	+32 29	34.0	1	
637	10 4	+29 40	42.6	5	
638	12 12	−19 5	7.4	10	
639	12 2	+19 2	25.1	10	
640	16 40	−19 5	8.9	10	
641	18 44	+15 48	26.0	1	
642	20 26	− 6 23	10.7	10	Twilight.
643	19 31	+25 3	26.6	5	
644	27 25	− 6 22	9.1	10	Twilight.
645	29 49	−19 6	8.3	10	
646	29 18	+11 58	11.7	10	Moon.
647	22 36 30	− 4 12	8.1	10	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
648	22 39 46	—19 5	5.0	10	
649	39 46	+16 54	17.3	10	
650	41 29	+14 1	16.5	10	
651	42 39	+28 57	20.1	10	
652	44 44	—19 5	7.1	10	
653	45 5	+18 56	18.5	10	
654	48 12	+ 8 48	19.0	1	
655	48 13	+25 5	21.3	10	
656	51 56	+30 45	26.7	10	Moon (faint)
657	53 33	+10 7	13.2	10	
658	53 29	+32 16	17.2	10	Moon.
659	22 57 9	+18 57	13.4	I0	
660	23 0 38	+12 11	8.2	10	Moon,
661	1 28	— 4 10	8.9	10	
662	4 2	+19 1	11.6	10	
663	5 13	+23 2	12.1	10	
664	6 49	+12 13	9.2	10	Moon.
665	9 32	—22 17	4.4	10	
666	8 38	+32 17	18.7	10	Moon.
667	11 17	+25 5	21.3	10	
668	14 34	—19 3	7.3	10	Moon.
669	17 38	— 4 6	7.5	10	Most extremely small.
670	18 25	+26 0	26.0	1	
671	19 58	+29 8	21.1	10	
672	21 8	+19 1	11.9	10	
673	26 26	+ 9 56	9.7	10	
674	23 32 28	+21 8	12.1	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.	Decl. 1860.	No. of Stars.	No. of fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
675	23 34 26	−22 16	3.1	10	
676	40 35	+21 5	9.5	10	
677	41 58	+11 11	10.0	1	
678	51 39	+21 6	10.9	10	
679	53 18	+45 33	50.0	1	
680	55 38	−22 20	4.2	10	
681	23 55 33	+25 21	15.3	10	
682	8 3	+ 3 47	5.6	10	
683	0 8 38	− 4 7	7.8	10	

XI.—THE STAR-GAUGES OF SIR WILLIAM HERSCHEL, REDUCED TO 1860.0. SECOND SERIES.

In the *Philosophical Transactions* for 1817, p. 325, SIR WILLIAM HERSCHEL says that beside the star-gauges printed in *Philosophical Transactions*, 1785, above 400 more have been taken in various parts of the heavens and are not published.

On referring this to LIEUT. COL. JOHN HERSCHEL, R. E., he kindly undertook the search for the unpublished gauges, and I owe to him and to MISS ROSE HERSCHEL a complete copy of a *ms* by MISS CAROLINE HERSCHEL, in which these are given, and also a list in which they are arranged in order of R. A.

The original Ms. by MISS CAROLINE HERSCHEL is prefaced by the following words in her own handwriting.

"The following gages begin with the 358 sweep. As far as 357 sweep, they are printed in the paper on the Construction of the Heavens. and their places have been given in FLAMSTEED'S time and polar distance. But these gages are calculated for the time when the observations were made, though as far as the 438 sweep, the places are down in the journals in FLAMSTEED'S time and P. D. But every gage is calculated twice, and after having been brought to the time of observation carried into this book."

COL. HERSCHEL has been kind enough to extract from the HERSCHEL Mss. at the Royal Astronomical Society's Rooms, the dates of the sweeps with which we are concerned, and they are given below.

THE DATES OF THE SWEEPS.

Sweep.	Date.	Sweep.	Date.	Sweep.	Date.
358	Jan. 27, 1785	388	Mar. 13, 1785	430	Sept. 1, 1785
359	28,	389	16,	431	3,
360	29,	390	Apr. 3,	438	12,
361	30,	391	3,	445	28,
362	31,	392	3,	447	Oct. 1,
363	31,	393	6,	451	3,
364	Feb. 1,	396	11,	459	6,
365	4,	397	11,	460	6,
366	4,	399	13,	461	8,
367	6,	400	14,	462	8,
368	7,	403	27,	465	26,
370	8,	405	May 1,	466	26,
371	8,	407	3,	467	27,
372	8,	408	3,	469	Nov. 7,
373	17,	409	5,	473	22,
374	28,	410	11,	474	22,
576	Mar. 1,	415	July 17,	477	23,
377	4,	416	30,	478	27,
378	5,	417	31,	479	28,
379	5,	418	Aug. 1,	481	29,
380	5,	419	6,	482	29,
381	6,	421	7,	485	Dec. 7,
382	10,	425	12,	486	7,
384	11,	426	27,	496	28,
385	12,	427	30,	497	28,
386	13,	428	31,	498	28,
387	13,	429	31,	499	30,

THE DATES OF THE SWEEPS — Continued.

Sweep.	Date.	Sweep.	Date.	Sweep.	Date.
500	Dec. 30, 1785	660	Dec. 21,	934	Mar. 4, 1790
502	30,	667	26,	959	Sept. 11,
506	Jan. 1, 1786	668	27,	963	Oct. 3,
508	2,	681	Jan. 11, 1787	969	Oct. 9,
511	27,	711	Mar. 15,	1014	May 28, 1791
523	Feb. 15,	712	15,	1022	Aug. 14, 1792
526	22,	715	17,	1023	19,
529	24,	716	18,	1024	22,
558	Apr. 30,	720	19,	1027	Sept. 15,
559	30,	722	20,	1043	May 12, 1793
561	May 1,	736	May 15,	1056	Oct. 5,
563	14,	762	Oct. 10,	1067	Dec. 10, 1797
569	28,	765	14,	1070	12,
584	Sept. 14,	815	Mar. 9, 1788	1077	Sept. 9, 1798
594	20,	816	9,	1080	Oct. 2,
598	21,	820	11,	1082	7,
600	22,	858	Sept. 9,	1093	Jan. 21, 1800
616	Oct. 18,	860	21,	1095	Mar. 15, 1801
626	26,	862	26,	1111	Sept. 26, 1802
641	Nov. 28,	866	27,		

Mr. TATLOCK has brought up the positions to 1860, without reduction from the apparent place to the beginning of the year of observation. That is by assuming the places given to belong to the beginning of the nearest year. The errors thus introduced are hardly greater than the errors of the original positions, and are less than the errors which will be introduced when these observations are discussed by any graphical process.

The following tables contain the original data, as given by Miss CAROLINE HERSCHEL, should a more accurate reduction be reqnired.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
2 51 43	95 59	7.4	10	353	
3 4 43	95 59	9.8	10	358	
3 50 57	96 41	8.0	10	359	Most of them excess. s. and same pr. l., but very few between.
2 54 17	61 27	16.1	10	360	
3 23 17	61 27	22	5	360	
3 30 23	62 11	33	1	360	
3 34 18	62 33	32	1	360	
4 0 43	62 27	0	1	360	
4 2 13	61 29	12.4	10	360	Unequally scattered.
4 4 13	61 29	11.3	4	360	
4 5 57	62 25	1	1	360	
4 22 13	61 29	18.2	5	360	
4 25 13	61 29	16.8	5	360	
4 30 12	61 29	15.6	5	360	
4 37 36	61 5	39	1	360	
5 11 32	61 15	80	½	360	
5 15 12	60 56	72	½	360	
5 41 44	61 23	120	½	360	
5 45 44	62 4	[112	½]	360	[See journa l] (in pencil).
5 49 14	61 54	118	½	360	
5 50 14	62 17	116	½	360	
5 52 19	61 35	108	½	360	
5 56 19	62 42	62	1	360	Faint moon light
6 47 37	62 58	36	1	361	Innum. too s.
6 49 37	63 23	92	½	361	With s. s.
6 52 37	62 54	73	1	361	Many more suspected.
7 7 37	62 52	66	½	361	
3 37 8	101 34	7.1	10	362	

ORIGINAL DATA OF SWEEPS — Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
3 50 6	101 35	8.8	10	362	
4 12 6	101 35	7.3	10	362	
4 25 6	101 35	7.7	10	362	
4 34 4	101 38	8.4	10	332	
4 47 4	101 38	10.7	10	362	
4 59 10	101 37	10.6	10	362	
5 7 11	101 36	13.5	10	362	
5 33 53	101 37	6.3	10	362	Unequally scattered.
5 26 47	100 33	4	1	362	See journal.
5 37 41	101 9	2	1	362	
5 38 11	102 43	20	1	362	
5 46 33	101 27	12.2	10	362	
6 9 53	37 21	21	10	362	
6 20 53	101 37	41.8	5	362	
7 8 27	101 32	37	1	363	
7 22 27	102 10	120	½	363	Changeable focus.
7 25 57	101 58	96	½	363	
7 27 27	102 14	100	½	363	
7 33 27	102 33	46	1	363	
7 35 27	101 17	52	1	363	
7 36 57	102 2	58	1	363	
7 45 27	102 45	47	1	363	
7 47 57	102 40	56	1	363	
7 56 27	102 3	54	1	363	
3 12 27	101 33	38	1	363	
3 56 16	103 38	8.2	10	364	
4 59 15	103 38	12.3	10	364	
3 26 4	105 53	7.9	10	365	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
3 53 4	105 48	8.9	10	365	
4 25 4	105 48	7.8	10	365	
4 52 17	105 51	12.3	10	365	
5 18 17	105 51	15.8	10	365	
5 29 6	105 50	20.5	10	365	
5 46 6	105 50	25.8	5	365	
6 11 15	106 54	50	1	365	
6 12 15	106 17	54	½	365	
6 13 45	106 3	40	1	365	
6 13 15	105 42	46	1	365	
6 23 15	105 25	75	1	365	
6 34 15	105 11	56	1	365	
7 14 15	105 5	90	1	366	
7 30 15	106 10	184	½	366	Many such f.
7 32 15	105 6	212	¼	366	
7 45 15	104 43	120	½	366	But a little hazy
7 49 15	106 39	216	½	366	Most s.
8 43 15	105 0	42	1	366	
9 44 15	105 49	16.0	10	366	
4 49 49	108 9	13.5	10	367	
5 13 30	108 9	16.2	10	367	
5 47 33	108 9	23.8	5	367	
6 2 33	108 9	31.2	5	367	
6 10 58	109 26	52	1	367	
6 15 58	106 52	34	1	367	
6 16 58	108 45	50	1	367	
6 23 30	109 28	32	1	367	
6 24 0	109 4	30	1	367	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweeps.	Remarks.
h. m. s.	° ′				
6 24 30	108 42	29	1	367	
6 25 0	103 18	32	1	367	
6 25 30	107 54	43	1	367	
6 26 0	107 31	25	1	367	
6 26 30	107 8	40	1	367	
6 42 29	109 27	40	1	367	
6 42 59	109 3	32	1	367	
6 43 20	108 40	41	1	367	
6 44 17	108 17	37	1	367	
9 32 40	107 58	18.0	10	368	
10 6 40	107 58	17.0	10	368	
11 25 41	107 59	8.6	10	368	
11 36 41	107 59	5.9	10	368	
12 36 41	107 59	9.6	10	368	
6 42 6	103 7	100	½	370	
6 44 6	103 29	116	½	370	
6 58 6	104 18	136	½	370	
9 13 59	103 52	19.0	5	371	
9 35 16	103 51	15.8	4	371	
10 42 38	104 48	8	1	371	
10 59 40	103 53	8.9	10	371	
11 58 12	103 52	10.3	10	372	
13 5 34	103 57	8.4	10	372	
13 26 9	103 53	6.9	10	372	
13 46 13	103 53	8.9	10	372	
13 52 13	103 53	10.2	10	372	
14 3 13	103 53	11.6	10	372	
14 12 12	103 51	10.3	10	372	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweeps.	Remarks.
h. m. s.	° ′				
14 30 12	103 51	11.6	10	372	
14 46 15	103 53	12.7	10	372	
15 18 58	64 51	9.9	10	373	
5 50 38	64 29	152	¼	374	Of all sizes.
6 11 36	64 45	104	½	374	
6 22 6	65 36	140	¼	374	
6 39 6	66 3	91	½	374	
6 42 22	64 21	96	½	374	
7 20 15	66 7	48	½	374	
7 20 45	65 39	54	½	374	
5 55 36	63 30	100	½	376	
6 31 59	97 26	60	1	377	
6 38 59	98 35	136	¼	377	
6 39 29	97 46	136	½	377	
6 44 59	98 14	120	¼	377	
7 0 59	97 31	128	¼	377	
7 1 59	97 5	184	¼	377	
7 7 59	96 19	132	½	377	
7 16 29	98 5	160	¼	377	
6 33 13	94 36	216	¼	378	
9 33 27	95 5	14.3	10	379	
10 21 28	95 9	9.6	10	379	
11 3 58	95 9	9.6	10	379	
11 50 42	95 7	9.6	10	379	
12 23 42	95 7	7.3	10	379	
13 31 29	95 38	7.6	10	380	
14 45 14	95 36	12.6	10	380	
6 34 14	113 36	40	1	381	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
6 37 32	114 27	33	1	381	
6 40 14	114 5	46	1	381	
6 47 44	113 40	42	1	381	
6 50 9	113 47	59	1	381	
7 1 45	114 12	46	1	381	
7 8 45	115 28	73	1	381	
7 12 45	115 30	150	⅓	381	Of all sizes.
7 23 13	114 40	78	1	381	
7 31 43	115 3	184	¼	381	
7 39 13	114 52	212	¼	381	
7 42 43	114 35	232	¼	381	
7 57 41	115 48	200	¼	381	
8 3 41	114 15	108	¼	381	Most s.
8 6 11	115 21	86	½	381	
8 14 41	115 16	58	1	381	
10 56 7	110 22	9.9	10	382	
11 12 52	110 22	10.5	10	382	
12 19 16	110 22	7.9	10	382	
12 48 5	110 23	8.3	11	382	
13 45 5	110 23	10.3	10	382	
14 8 5	110 23	9.4	10	382	
6 50 36	64 59	44	1	384	Faint twilight etc.
7 4 29	62 16	36	1	384	
7 54 33	63 5	17.8	10	384	
8 23 35	63 8	14.7	10	384	
7 22 29	61 55	32	1	385	
7 22 59	61 21	30	1	385	
7 23 39	60 49	22	1	385	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remark.
h. m. s.	° ′				
7 39 39	61 44	39.	1	385	
7 42 39	60 48	23.4	5	385	
8 53 11	60 44	13.8	10	385	
9 38 41	60 43	9.2	10	385	
7 45 20	58 58	25.	1	386	F. moon light.
9 36 44	58 41	8.7	10	386	
9 47 39	58 38	8.0	10	386	
10 11 29	58 38	6.6	10	386	
10 32 9	58 38	5.5	10	386	
13 20 54	58 39	7.7	10	387	
15 25 44	56 43	9.2	10	388	
15 38 44	50 43	12.5	10	388	
15 54 20	56 38	12.9	10	388	
14 7 49	16 19	11.6	5	389	
15 33 56	16 18	10.1	10	389	
10 0 26	16 18	15.5	10	389	
10 11 19	16 4	11.2	10	390	
10 47 19	16 4	10.0	10	390	
11 23 19	16 4	11.2	10	390	
13 32 28	16 6	9.3	10	391	
15 46 4	14 12	13.9	10	392	
10 18 28	62 59	8.3	10	393	
11 16 16	63 0	6.6	10	393	
11 53 12	62 58	4.3	10	393	
12 5 12	62 58	5.3	10	393	
13 9 19	62 59	5.3	10	393	
13 47 19	62 59	5.4	10	393	
13 16 43	60 47	5.6	10	396	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
13 17 43	60 47	6.6	10	396	
14 55 39	60 46	7.0	10	397	
13 29 22	67 22	5.4	10	399	
13 50 23	67 25	5.0	10	399	Most of them s.
14 5 30	67 22	5.8	10	399	
14 45 20	67 13	6.5	10	399	
15 26 47	91 32	7.1	10	400	Chiefly s.
15 55 40	91 34	11.9	10	400	Chiefly s.
16 0 41	91 33	16.2	10	400	Of various sizes
13 5 16	69 0	6.4	10	403	
13 9 16	69 0	4.6	10	403	
14 44 28	53 11	9.0	10	405	
14 58 58	53 11	7.2	10	405	
15 47 6	53 12	9.3	10	405	
12 48 52	55 15	6.4	10	407	Most s. and many v. s. suspected.
15 26 24	55 12	7.0	10	408	
16 15 5	87 19	17.9	9	409	
15 28 41	87 24	15.0	10	410	Mr. Aubert.
15 35 41	87 24	14.2	10	410	W. H.
15 39 41	87 24	14.5	10	410	Mr. Aubert.
16 22 40	87 23	11.8	10	410	Mr. Aubert.
20 6 24	67 29	93	1	415	
18 54 56	87 29	90	1	416	
19 18 21	87 4	150	1	416	
20 12 5	88 4	46	1	417	
20 13 35	87 4	41.4	5	417	
19 2 23	118 21	26.2	5	418	
19 55 24	118 24	10.5	10	418	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
20 27 21	118 21	10.9	10	418	
20 42 21	118 21	6.9	10	418	
21 2 21	118 20	6.5	10	418	
21 12 13	79 54	28	1	419	
19 59 57	84 31	92	½	421	
20 16 27	85 2	45	1	421	
20 20 57	85 40	67	1	421	
20 21 27	85 29	50	1	421	
20 22 38	85 5	48	1	421	
20 23 40	85 41	52	1	421	
20 24 48	84 16	40	1	421	
20 25 46	83 52	43	1	421	
22 20 3	90 42	9.2	1*	425	* [Sic in MS.]
22 28 33	90 42	9.2	1*	425	* [Sic in MS.]
19 15 17	86 59	220	¼	42–	[sw. not entered. ? 6, 7, 8, 9.]
19 25 32	86 27	172	¼	42–	[sw. not entered. ? 6, 7, 8, 9.]
19 38 32	87 22	144	¼	42–	[sw. not entered. ? 6, 7, 8, 9.]
21 1 37	86 41	18.2	10	42–	[sw. not entered. ? 6, 7, 8, 9.]
22 12 32	86 42	10.7	10	42–	[sw. not entered. ? 6, 7, 8, 9.]
23 17 35	86 41	5.0	10	42–	[sw. not entered. ? 6, 7, 8, 9.]
20 19 25	120 29	7.2	10	430	Very clear and with great attention.
20 53 25	120 29	4.3	10	430	
21 30 25	120 29	4.5	10	430	
22 34 34	120 31	2.9	10	430	
23 16 23	120 30	2.3	10	430	
23 37 32	120 30	2.4	10	430	
0 30 28	120 30	1.5	10	430	
20 42 15	94 26	18.4	5	431	

ORIGINAL DATA OF SWEEPS — Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
23 34 40	96 21	3.4	10	438	The s. spcc. affected by damp.
23 22 7	110 18	5.6	10	445	
23 49 7	110 18	5.9	10	445	
22 31 14	92 20	7.8	10	447	
22 45 15	92 20	7.2	10	447	
0 2 19	105 5	6.3	10	451	
0 13 19	105 5	4.7	10	451	
2 5 53	105 4	4.5	10	451	
2 21 5	108 17	4.8	10	459	
5 41 13	119 0	8.1	10	460	
22 54 20	88 35	7.1	10	461	
0 11 17	88 41	5.6	10	461	
2 19 21	88 38	7.5	10	462	
21 52 52	115 0	5.8	10	465	
22 3 52	115 0	5.8	10	465	
22 35 52	115 2	4.9	10	465	
22 56 52	115 2	2.8	10	465	
23 9 52	115 2	3.5	10	465	
28 49 52	115 2	4.0	10	465	
0 8 52	115 2	2.3	10	465	
1 15 52	115 0	3.6	10	465	
1 34 52	115 0	3.6	10	465	
3 17 52	117 6	3.6	10	466	
21 48 47	117 0	6.2	10	467	
22 39 43	117 2	3.3	10	467	
23 32 43	117 3	4.8	10	467	
1 6 43	117 2	2.5	10	467	
23 34 3	90 37	7.2	10	469	

ORIGINAL DATA OF SWEEPS — Continued.

R. A.	N. P. D.	No. Stars.	No. Guages.	Sweep.	Remarks.
h. m. s.	° ′				
0 4 13	90 39	5.5	10	469	
23 24 43	92 30	6.3	10	473	
1 46 6	96 12	3.5	2	474	
0 28 24	80 8	7.1	10	477	
23 2 29	103 17	6.1	10	478	
23 13 32	103 17	5.3	10	478	
2 31 16	103 16	6.6	10	478	
3 13 41	103 16	6.0	10	478	Most s.
22 56 21	101 21	6.3	10	479	
23 47 15	101 21	6.0	10	479	
1 4 22	101 24	6.1	10	479	
1 9 50	71 31	11.2	10	481	
2 12 2	71 29	6.9	10	481	
4 31 27	71 29	14.3	10	482	
4 44 43	71 29	22.8	5	482	All sizes.
5 32 21	66 6	66	1	485	Many s. s. too s. for the gauge.
6 21 31	63 47	88	½	486	
5 48 44	81 42	120	½	496	
6 2 52	81 38	136	½	496	
6 12 22	81 47	200	¼	496	
9 2 54	81 17	12.3	10	497	
11 17 55	81 11	6.3	10	498	
1 21 40	106 47	6.4	10	499	
4 41 30	116 40	5.5	10	500	
5 23 30	116 49	11.6	10	500	
9 22 29	117 47	14.8	10	502	
10 17 54	117 48	9.9	10	502	
6 51 47	90 59	180	½	506	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
6 52 37	91 44	192	¼	506	
11 26 5	54 22	5.6	10	508	
4 35 37	84 32	22.6	5	511	
16 47 18	22 58	15.8	10	523	
17 1 2	23 55	18.6	5	523	
7 6 42	88 48	160	¼	526	
7 25 40	97 54	104	½	529	
7 39 30	98 8	92	½	529	
7 50 55	97 3	45	1	529	
13 10 28	85 53	6.8	10	558	
13 54 0	85 53	8.3	10	558	
16 40 35	119 1	27.6	10	559	
16 41 32	83 59	19.1	10	561	
15 22 36	89 32	11.4	10	560	
17 27 13	.....	.....	.....	569	The stars very unequally scattered.
17 27 33	109 47	0	1	569	
17 27 53	110 40	34	1	569	
19 54 45	79 53	252	¼	584	
20 40 44	54 33	320	¼	594	Besides many too s. to be distinctly seen.
21 12 46	52 32	272	¼	598	Most very s.
20 55 42	52 16	220	¼	600	
21 55 12	66 34	46	1	616	
1 2 42	63 25	14.8	10	626	
2 17 33	63 26	13.2	10	626	
6 54 35	95 2	232	¼	641	
12 18 51	111 53	5.0	10	660	
7 25 19	86 11	112	¼	667	
7 26 49	87 33	52	½	667	

ORIGINAL DATA OF SWEEPS — Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
7 28 19	86 22	48	½	667	
6 4 23	89 22	104	¼	668	But one of the richest places, etc.
6 41 2	88 31	116	½	668	See mem. 8′ after the guage.
3 18 48	75 18	9.2	10	681	
3 32 18	75 18	7.5	10	681	
3 47 18	75 18	8.7	10	681	
3 57 48	75 18	6.1	10	681	
12 21 18	119 33	9.4	10	711	
16 7 51	121 35	13.6	10	712	
15 54 37	50 50	16.7	10	716	
9 43 0	48 34	10.4	10	716	
10 32 47	48 33	7.0	10	716	Time forgot [to be ent.] betw. 14h 3′ and 15h 15′.
.....	74 18	11.2	10	720	
14 12 43	56 44	10.0	10	722	
13 45 38	39 19	8.4	10	736	
22 12 9	12 1	2.3	10	762	Most extr. s.
21 48 20	38 4	280	¼	765	See mem. on appearance of the heavens.
21 50 50	38 9	336	¼	765	
8 54 40	39 49	12.6	10	815	
12 36 29	39 48	8.0	10	815	
14 0 44	107 52	10.8	10	820	
2 17 12	44 38	60	½	858	
2 18 12	44 59	72	½	858	
2 19 32	44 57	68	½	858	
21 28 49	41 4	360	¼	860	But most of them v. s. n.
20 52 55	39 49	15	1	862	These guages show, etc.
20 53 15	38 54	41	1	862	
20 54 55	40 20	17	1	862	

ORIGINAL DATA OF SWEEPS—Continued.

R. A.	N. P. D.	No. Stars.	No. Gauges.	Sweep.	Remarks.
h. m. s.	° ′				
20 59 32	43 49	360 to 400	¼	866	
21 2 32	43 41	280	¼	866	
6 57 29	107 32	100	¼	934	
6 58 54	107 27	128	¼	934	All sizes.
8 34 54	105 44	38	1	934	The stars have been gradu'lly reduced to this number, and are still decreasing.
8 36 22	107 10	43	1	934	
8 41 54	107 43	17	1	934	
8 43 24	107 24	26	1	934	
8 43 54	108 0	15	1	934	
8 44 39	107 13	16	1	934	
8 47 54	107 42	14.2	10	934	
8 55 54	107 42	11.6	10	934	
19 49 56	47 3	240	¼	959	With many too small to be counted.
19 52 56	48 4	264	¼	959	
20 52 52	66 45	184	¼	963	
20 30 58	44 55	172	¼	969	
20 31 58	43 52	232	¼	969	
17 26 58	55 35	41.2	5	1014	
21 13 49	82 10::	40	1	1022	
19 34 5	72 11	360	¼	1023	36,593 stars have been seen in 6′. See mem.
19 35 23	75 5	600::	¼	1024	
19 53 20	74 11	440	¼	1024	
20 5 20	72 54	360	¼	1024	
20 16 20	73 5	260	½	1024	See the rest of memorandum.
19 41 54	52 26	480	¼	1027	
19 45 54	52 29	612	¼	1027	The whole breadth equally rich.
17 37 2	103 11	60	1	1043	But is one of the richest fields now.
20 16 48	98 16	80	½	1056	

ORIGINAL DATA OF SWEEPS — Continued.

R. A. 1880.			N. P. D.		No. Stars.	No. Gauges.	Sweep.	Remarks.
h.	m.	s.	°	′				
10	36	53	23	40	18.2	10	1036	
15	36	0	12	16	14.8	10	1067	
14	38	0	13	24	17.2	10	1070	
19	46	15	30	23	112	½	1077	
20	40	41	20	34	48	1	1080	
21	20	41	21	47	32	1	1080	Probably affected by haziness.
0	17	58	15	32	96	1	1082	
5	33	—	73	18	120	1	1093	
7	41	--	108	28	176	¼	1095	
8	58	11	9	6	60—70	1	1111	
9	50	11	9	8	20—30	1	1111	

The table immediately following contains the reduction of these observations to 1860. The numbers in the first column continue those assigned by Sir WILLIAM HERSCHEL to his first series.

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
684	0 6 6	104 40	6.3	10	
685	8 0	90 14	5.5	10	
686	12 38	114 37	2.3	10	
687	15 4	88 16	5.6	10	
688	17 5	104 40	4.7	10	
689	21 28	15 12	96.0	1	
690	32 13	79 44	7.1	10	
691	0 34 8	120 6	1.5	10	
692	1 6 39	63 2	14.8	10	
693	8 2	101 0	6.1	10	
694	10 16	116 38	2.5	10	
695	13 48	71 7	11.2	10	
696	19 24	114 37	3.6	10	
697	25 17	106 24	6.4	10	
698	38 21	114 37	3.6	10	
699	1 49 49	95 50	3.5	2	
700	2 9 26	104 43	4.5	10	
701	16 8	71 8	6.9	10	
702	21 45	44 18	60.0	½	
703	21 43	63 6	13.2	10	
704	22 44	44 39	72.0	½	
705	23 8	88 18	7.5	10	
706	24 5	44 37	68.0	½	
707	24 34	107 57	4.8	10	
708	34 49	102 56	6.6	10	Most of them excessively small and some pretty large, but very few between.
709	55 27	95 41	7.4	10	
710	2 58 45	61 9	16.1	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
711	3 8 26	95 42	9.8	10	
712	17 11	103 0	6.0	10	Mostly small.
713	21 1	116 50	3.6	10	
714	22 52	75 2	9.2	10	
715	27 49	61 11	22	5	
716	29 31	105 38	7.9	10	
717	34 55	61 56	33	1	
718	36 23	75 3	7.5	10	
719	38 45	62 18	32	1	
720	40 42	101 19	7.1	10	
721	51 23	75 5	8.7	10	
722	53 39	101 21	8.8	10	
723	54 37	96 28	8.0	10	
724	3 59 45	103 25	8.2	10	
725	4 1 53	75 5	6.1	10	
726	1 30	105 35	8.9	10	
727	5 19	62 15	0.0	1	
728	6 50	61 17	12.4	10	Unequally scattered.
729	8 51	61 17	11.3	4	
730	10 14	62 13	1.–	1	
731	15 38	101 24	7.3	10	
732	26 53	61 19	18.2	5	
733	28 38	101 25	7.7	10	
734	29 54	61 19	16.8	5	
735	28 29	105 38	7.8	10	
736	34 53	61 19	5.6	5	
737	4 35 44	71 19	14.3	10	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
738	4 37 35	101 29	8.4	10	
739	39 33	84 23	22.6	5	
740	42 18	60 56	39.	1	
741	44 31	116 38	5.5	10	
742	49 1	71 20	22.8	5	All sizes.
743	50 34	101 30	10.7	10	
744	53 8	108 1	13.5	10	
745	4 55 40	105 44	12.3	10	
746	5 2 41	101 30	10.6	10	
747	2 42	103 31	12.3	10	
748	10 42	101 30	13.5	10	
749	16 16	61 10	80.	½	
750	16 48	108 4	16.2	10	
751	19 57	60 51	72.	½	
752	21 39	105 46	15 8	10	
753	26 28	116 40	11.6	10	
754	32 29	105 47	20.5	10	Many small stars too small for the gauge.
755	36 52	66 3	66.	1	
756	36 28	73 16	120.	1	
757	37 23	101 34	10.3	10	Unequally scattered.
758	40 19	100 30	4.	1	See Journal.
759	41 12	101 7	2.	1	
760	41 39	102 41	20.	1	
761	44 5	118 58	8.1	10	
762	46 27	61 21	120.	½	
763	50 27	62 3	112.	½	See Journal, [in pencil.]
764	49 28	105 49	25.8	5	
765	5 50 23	101 36	12.2	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL's Remarks.
	h. m. s.	° ′			
766	5 50 50	108 8	23.8	5	
767	52 46	81 41	120	½	
768	53 58	61 53	118	½	
769	54 57	62 16	116	½	
770	55 16	64 28	152	¼	Of all sizes.
771	5 57 3	61 34	108	½	
772	6 0 16	63 29	160	½	
773	1 1	62 42	62	1	Faint moonlight.
774	5 50	108 9	31.2	5	
775	6 54	81 38	136	½	
776	8 8	89 22	104	¼	But one of the richest places, etc.
777	13 23	101 38	21.1	10	
778	15 28	109 27	52	1	
779	14 35	106 55	50	1	
780	16 14	64 46	104	½	
781	15 36	106 18	54	½	
782	16 24	81 48	200	¼	
783	17 6	106 4	40	1	
784	19 18	106 53	34	1	
785	20 15	106 47	50	1	
786	21 38	105 44	46	1	
787	24 23	101 39	41.8	5	
788	26 7	63 49	88	½	
789	26 42	65 38	140	¼	
790	26 48	105 27	75	1	
791	26 45	109 30	32	1	
792	27 16	109 6	30	1	
793	6 27 46	108 44	29	1	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0	N. P. D. 1860.0	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
794	6 28 17	108 20	32.	1	
795	28 48	107 56	43.	1	
796	29 19	107 33	25.	1	
797	29 50	107 10	40.	1	
798	35 37	97 29	60.	1	
799	36 55	94 59	216.	¼	
800	37 15	113 39	40.	1	
801	37 48	105 14	56.	1	
802	40 37	114 31	33.	1	
803	42 34	98 39	136.	¼	
804	43 41	66 7	94.	½	
805	43 6	97 50	136.	½	
806	43 20	114 9	46.	1	
807	44 49	88 35	116.	½	See mem. 8′ after the gauge.
808	45 34	103 11	100.	½	
809	47 0	64 25	96.	½	
810	45 45	109 31	40.	1	
811	46 16	109 7	32.	1	
812	46 37	108 45	41.	1	
813	47 35	108 22	37.	1	
814	47 33	103 34	116.	½	
815	48 35	98 19	120.	¼	
816	52 17	63 3	36.	1	Large and innumerable, too small, etc.
817	50 51	113 45	42.	1	
818	54 17	63 28	92.	½	
819	53 17	113 52	59.	1	With small stars.
820	55 12	65 4	44.	1	Faint twilight, etc.
821	6 55 33	91 5	180.	⅓	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
822	6 57 17	62 59	73	1	Many more suspected.
823	56 21	91 50	192	¼	
824	6 58 11	95 8	232	¼	
825	7 0 35	107 38	100	¼	
826	1 32	104 24	136	½	
827	52 1	107 33	128	¼	Of all sizes.
828	4 35	97 37	128	¼	
829	4 52	114 19	46	1	
830	5 37	97 12	184	¼	
831	9 10	62 23	36	1	
832	10 31	88 55	160	¼	
833	12 17	62 59	66	½	
834	11 18	96 56	132	½	
835	11 58	101 39	37	1	
836	11 50	115 35	73	1	
837	15 0	115 38	150	⅓	Of all sizes.
838	17 40	105 13	90	1	
839	20 6	98 13	160	¼	
840	24 47	66 15	48	½	
841	25 18	65 48	54	½	
842	25 57	102 19	120	½	Changeable focus.
843	27 9	62 4	32	1	
844	27 40	61 30	30	1	
845	26 21	114 49	78	1	
846	28 22	60 58	22	1	
847	29 28	102 7	96	½	
848	29 10	86 20	112	¼	
849	7 30 37	87 42	52	½	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N.P.D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
850	7 30 57	102 23	100	½	
851	32 9	86 31	48	½	
852	32 15	98 40	104	½	
853	33 38	106 20	184	½	Many such fields.
854	34 51	115 13	184	¼	
855	35 41	105 16	212	¼	
856	36 57	102 43	46	1	
857	38 59	101 27	52	1	
858	40 28	102 12	58	1	
859	42 21	115 13	212	¼	
860	43 5	98 19	92	½	
861	44 19	61 55	39	1	
862	43 37	108 36	176	¼	
863	47 19	60 59	23.4	5	
864	45 52	114 46	232	¼	
865	48 42	104 54	120	½	But a little hazy.
866	50 4	59 59	25	1	Faint moonlight
867	48 57	102 56	47	1	
868	51 27	102 51	56	1	
869	52 38	106 50	216	½	Mostly small
870	54 32	97 14	45	1	
871	59 8	63 17	17.8	10	
872	7 59 58	102 15	54	1	
873	8 0 48	116 0	200	¼	
874	6 53	114 28	108	¼	Mostly small
875	9 21	115 34	86	½	
876	16 0	101 46	38	1	
877	8 17 52	115 30	58	1	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
878	8 28 16	63 22	14.7	10	The stars have been gradually reduced to this number and are still decreasing.
879	38 9	105 58	38	1	
880	39 35	107 25	43	1	
881	45 7	107 58	17	1	
882	46 45	105 16	42	1	
883	46 37	107 39	26	1	
884	47 6	108 15	15	1	
885	47 52	107 28	16	1	
886	51 7	107 58	14.2	10	
887	57 43	61 1	13.8	10	
888	59 45	40 6	12.6	10	
889	8 59 7	107 58	11.6	I0	
890	9 6 45	9 18	60–70	1	
891	6 52	81 35	12.3	10	
892	17 33	104 11	19.0	5	
893	25 43	118 16	14.8	10	
894	36 11	108 18	18.0	10	
895	37 12	95 25	14.3	10	
896	38 52	104 11	15.8	4	
897	41 10	59 1	8.7	10	
898	43 3	61 3	9.2	10	
899	47 33	48 54	10.4	10	
900	47 50	106 10	16.0	10	
901	52 3	58 59	8.0	10	
902	9 57 20	9 24	20–30	1	
903	10 10 15	108 20	17.0	10	
904	17 48	16 26	11.2	10	
905	15 57	59 0	6.6	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
906	10 21 18	118 10	9.9	10	
907	22 40	63 21	8.3	10	
908	25 12	95 32	9.6	10	
909	36 22	59 1	5.5	10	
910	37 3	48 56	7.0	10	
911	41 31	24 1	18.2	10	
912	46 19	105 11	8.	1	
913	52 58	16 27	10.0	10	
914	10 59 47	110 46	9.9	10	
915	11 3 24	104 17	8.9	10	
916	7 46	95 34	9.6	10	
917	16 35	110 47	10.5	10	
918	20 15	63 25	6.6	10	
919	21 45	81 36	6.3	10	
920	28 5	16 29	11.2	10	
921	29 27	108 24	8.6	10	
922	30 3	54 47	5.6	10	
923	40 28	108 24	5.9	10	
924	54 32	95 32	9.6	10	
925	11 57 4	63 23	4.3	10	
926	12 2 2	104 17	10.3	10	
927	9 2	63 23	5.3	10	
928	22 39	112 18	5.0	10	
929	23 10	110 37	7.9	10	
930	25 7	119 58	9.4	10	
931	27 33	95 32	7.3	10	
932	39 53	40 12	8.0	10	
933	40 36	108 23	9.6	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
934	12 52 3	110 47	8.3	10	Mostly small and many very small suspected.
935	12 52 28	55 39	6.4	10	
936	13 8 56	69 24	6.4	10	
937	9 31	104 21	8.4	10	
938	12 55	69 24	4.6	10	
939	12 54	63 23	5.3	10	
940	14 13	86 17	6.8	10	
941	20 15	61 10	5.6	10	
942	21 15	61 10	6.6	10	
943	24 23	59 3	7.7	10	
944	30 8	104 17	6.9	10	
945	32 56	67 45	5.4	10	
946	35 15	96 1	7.6	10	
947	34 2	16 29	9.3	10	
948	49 12	110 45	10.3	10	
949	48 30	39 41	8.4	10	
950	50 21	104 15	8.9	10	
951	50 46	63 21	5.4	10	
952	53 54	67 47	5.0	10	Most of them small.
953	56 15	104 15	10.2	10	
954	13 57 44	86 15	8.3	10	
955	14 4 41	108 14	10.8	10	
956	7 15	104 15	11.3	10	
957	8 58	67 43	5.8	10	
958	8 38	16 40	11.6	5	
959	12 15	110 44	9.4	10	
960	16 15	104 12	10.3	10	
961	15 52	57 4	10.0	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N.P.D.1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
962	14 34 17	104 11	11.6	10	
963	37 29	13 40	17.2	10	
964	47 32	53 30	9.0	10	
965	49 11	95 55	12.6	10	
966	48 42	67 32	6.5	10	
967	50 22	104 12	12.7	10	
968	14 58 51	61 4	7.0	10	
969	15 1 56	53 29	7.2	10	
970	22 14	65 6	9.9	10	
971	26 22	89 47	11.4	10	
972	28 43	56 59	9.2	10	
973	29 19	55 28	7.0	10	
974	30 39	91 48	7.1	10	Chiefly small.
975	32 27	87 39	15.0	10	Mr. Aubert.
976	33 11	16 33	10.1	10	
977	39 27	87 39	14.2	10	W. H.
978	34 26	13 30	14.8	10	
979	41 43	56 58	12.5	10	
980	43 27	87 38	14.5	10	Mr. Aubert.
981	44 24	14 26	13.9	10	
982	51 9	53 26	9.3	10	
983	57 14	56 52	12.9	10	
984	57 14	51 3	16.7	10	
985	59 32	91 47	11.9	10	Chiefly small.
986	59 19	16 31	15.5	10	
987	16 4 34	91 46	16.2	10	Of various sizes.
988	12 28	121 47	13.6	10	
989	18 51	87 30	17.9	9	

REDUCTION OF STAR-GAUGES—Continued.

No.	R. A. 1860.0	N. P. D. 1860.0	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
990	26 26	87 33	11.8	10	Mr. Aubert.
991	45 14	119 9	27.6	10	
992	45 10	84 7	19.1	10	
993	47 24	23 6	15.8	10	
994	17 3 0	24 1	18.6	5	
995	29 28	55 38	41.2	5	
996	31 55	109 50	0.	1	
997	32 17	110 43	34.	1	
998	17 40 38	103 13	60.	1	But is one of the richest fields etc.
999	18 58 39	87 23	90.	1	
1000	19 7 3	118 14	26.2	5	
1001	19 0	86 51	220.	¼	Sw. not entered? 6, 7, 8, 9.
1002	22 4	86 56	150.	1	
1003	29 14	86 18	172.	¼	Sw. not entered? 6, 7, 8, 9.
1004	37 5	72 2	360.	¼	See mem., 36598 stars have been seen in 6.
1005	38 27	74 56	600.	¼	
1006	42 15	87 12	144.	¼	Sw. not entered; 6, 7, 8, 9.
1007	44 17	52 16	480.	¼	
1008	47 18	30 14	112.	½	The whole breadth equally rich, see mem. with many too small to be counted.
1009	48 19	52 19	612.	¼	
1010	52 12	46 52	240.	¼	
1011	55 15	47 53	264.	¼	
1012	56 24	74 0	440.	¼	
1013	58 14	79 41	252.	¼	
1014	19 59 59	118 12	10.5	10	
1015	20 3 36	84 19	92.	½	
1016	8 22	72 42	360.	¼	
1017	9 36	67 16	93.	1	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860. 0.	N. P. D. 1860.0	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
1018	15 49	87 51	46	1	
1019	17 18	86 51	41.4	5	
1020	19 24	72 53	260	½	See rest of memoranda.
1021	20 8	84 48	45	1	
1022	20 21	98 4	80	½	
1023	24 0	120 15	7.2	10	Very clear and with great attention.
1024	24 38	85 25	67	1	
1025	25 8	85 14	50	1	
1026	26 19	84 50	48	1	
1027	27 20	84 26	52	1	
1028	28 27	84 1	40	1	
1029	29 24	83 39	43	1	
1030	31 35	118 7	10.9	10	
1031	33 17	44 41	172	¼	
1032	33 15	43 38	232	¼	
1033	41 50	20 21	48	1	Besides many too small to be distinctly seen.
1034	43 35	54 17	320	¼	
1035	46 8	94 10	18.4	5	
1036	46 49	118 5	6.9	10	
1037	55 56	66 29	184	¼	
1038	55 11	39 33	15	1	Note illegible in *my* copy.
1039	55 31	38 38	41	1	
1040	57 55	120 12	4.3	10	
1041	57 12	40 4	17	1	
1042	20 58 32	51 59	220	¼	
1043	21 2 0	43 32	360–400	¼	
1044	5 20	86 23	18.2	10	[Sw. not entered. ? 6, 7, 8, 9.
1045	6 46	118 2	6.5	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
1046	21 6 3	43 24	280.	¼	
1047	15 48	79 36	28.	1	
1048	16 40	52 14	272.	¼	Mostly very small.
1049	17 7	81 53	40.	1	*Probably affected by haziness.
1050*	21 38	21 31	32.	1	
1051	31 20	40 45	360.	¼	But most of them so small, etc.
1052	34 48	120 9	4.5	10	
1053	51 55	37 44	280.	¼	See mem. on appearance of heavens.
1054	53 2	116 39	6.2	10	
1055	53 26	37 49	336.	¼	
1056	57 4	114 39	5.8	10	
1057	21 58 34	66 13	46.	1	
1058	22 8 2	114 38	5.8	10	
1059	14 16	11 40	20.3	10	Mostly extra small.
1060	16 17	86 20	10.7	10	[Sw. not entered ?, 6, 7, 8, 9.]
1061	23 51	90 20	9.2	1	[Sic in m. s.]
1062	32 21	90 19	9.2	1	[Sic in m. s.]
1063	35 3	91 57	7.8	10	
1064	38 43	120 18	2.9	10	
1065	39 56	114 39	4.9	10	
1070	43 48	116 39	3.3	10	
1071	49 4	91 57	7.2	10	
1072	22 58 6	88 21	7.1	10	
1073	23 0 14	100 57	6.3	10	
1074	0 52	114 38	2.8	10	
1075	6 22	102 53	6.1	10	
1076	13 50	114 38	3.5	10	
1077	17 24	102 53	5.3	10	

REDUCTION OF STAR-GAUGES — Continued.

No.	R. A. 1860.0.	N. P. D. 1860.0.	No. Stars.	No. Fields.	HERSCHEL'S Remarks.
	h. m. s.	° ′			
1078	23 20 26	120 5	2.3	10	
1079	21 21	86 16	5.0	10	Sw. not entered, ? 2, 6, 7, 8, 9.
1080	26 0	109 53	5.6	10	
1081	28 31	92 5	6.3	10	
1082	36 36	116 38	4.8	10	
1083	37 50	90 14	7.2	10	
1084	38 29	95 56	3.4	10	
1085	41 21	120 5	2.4	10	The small speculum affected by damp.
1086	51 4	95 56	6.0	10	
1087	52 56	109 53	3.9	10	
1088	23 53 41	114 37	4.0	10	

XII. COUNTS OF STARS FROM THE CELESTIAL CHARTS OF DR. C. H. F. PETERS, PROF. J. C. WATSON, THE PARIS CHARTS OF CHACORNAC (COMPLETED BY DR. PETERS) AND THE ECLIPTIC-CHARTS OF HERR J. PALISA.

In May 1878 I had the pleasure of visiting Dr. C. H. F. PETERS at his observatory and of inspecting his series of celestial charts, then unpublished. He was kind enough to allow me to make a count of the number of stars contained in each 4m of R. A. by 1° in Dec. on every one of his maps then completed. I counted the stars on very many of the Paris charts which Dr. PETERS had also completed by inserting the missing stars. Such Paris charts as I counted were in every way comparable with those which Dr. PETERS had himself made, and for the present purpose they may be considered a part of the same series. At the date of my counting, the maps were regarded as practically completed down to a certain magnitude. I myself made a careful comparison of a map (No. I of the published charts) with the sky, and no stars were omitted except the very faintest—those which could only be seen with careful attention in a perfectly dark field with the eye protected from all extraneous light. The *minimum visibile* of Dr. PETERS' telescope (aperture 13.5 inches) is 14.8 or 14.9 mag. on ARGELANDER'S DM. scale extended. The stars omitted could not have been above 13.5 mag.

The maps counted were selected for me by Dr. PETERS, and were all equally complete up to this point. So that the numbers which are given in the table first following, so far as they are derived from Dr. PETERS' *ms.* maps, and from CHACORNAC'S charts, completed by DR. PETERS, are to be considered as homogeneous *gauges* or counts of all stars existing in the squares counted, from the brightest stars down to a certain (unknown) magnitude. This unknown magnitude cannot be far from the 14th. Exactly what it is, can be determined in the following way. Some of the squares of Dr. PETERS' charts, and of CHACORNAC'S charts, as completed by Dr. PETERS fall on the areas within which the Harvard

college observatory intends to determine the magnitude of each star separately, in order to establish standards of stellar magnitude. Fortunately for this purpose I have a photo-lithographic proof of PETERS' (published) Chart No. I, which was made in 1878, and which therefore accurately represents the state of his *ms.* maps at this time, before they had been repeatedly revised. This has been carefully compared with the map as published. All of the stars added since 1878 may be considered as being of the 13th magnitude, or fainter. In comparing these maps I have seen that the lines of R. A. and Dec. have been redrawn by the photo-lithographer, and that in a few cases stars have been covered up by the process. This should be noted by the owners of the charts. The CHACORNAC charts are now in exactly the same state as when I counted them, as are also some of the *ms.* (unpublished) charts of Dr. PETERS. A comparison of these with the Harvard college results will show the limiting magnitude of the counts which immediately follow (Table I). I cannot too strongly insist on the fact that these numbers represent the numbers of stars which actually exist in the sky down to a certain magnitude (as yet not determined) as accurately, or even more accurately, than a series of gauges would do, if the gauges were made with a telescope smaller than Dr. PETERS' Clinton refractor, say of twelve inches aperture.

Since my counts were made, Dr. PETERS has published, at his own expense, twenty of these celestial charts which are now in the hands of Astronomers, by his kindness. These twenty are no longer in the state in which they were when I counted (certain parts) of them. *Every* star visible in the Clinton refractor down to the very limit of visibility has been inserted by repeated revisions and re-revisions, so that we really have a new and most accurate series of gauges in which the smallest star included is about of the 14.8 magnitude.

The exact limit of magnitude of the published charts can be determined in the same way as before. The force of the statement that we have here *two series* of gauges, one from Dr. PETERS' *ms.* maps and one from his published maps can

only be appreciated after a careful study of the sky with his published maps and the identification of all the stars laid down by Dr. PETERS in a certain region. It can only be appreciated fully, by going through my own experience: that is after having compared a whole map (5 degrees square) and identifying every star; by comparing this map with others in *ms.*, and then with the published map, and finally by comparing the published map with the sky. I might properly add that an acquaintance with Dr. PETERS' most methodical and elegant methods of work is also necessary. I therefore believe that the following tables furnish us with two series of star gauges of great accuracy.

The series from the *ms.* maps, Table I, gives every star from the brightest down to a faint magnitude as yet undetermined (say A). The series from the published maps, Table II. gives every star down to the faintest visible (say B). A comparison of the two will give all the stars of the magnitudes between A and B. I believe the counts in these two tables are of equal importance with a series of independent gauges, made especially for the purpose of determining the number of stars in each field, and in some respects they are even superior to such gauges.

Table I contains all these counts from DR. PETERS' ms. maps, and from CHACORNAC's charts (completed.) The table gives *first*, the current number, *second*, the R. A., and *third*, the Declination of the middle of the space counted (4 m. in R. A. by 60′ in Dec.) for 1860, *fourth*, the number of stars actually mapped, *fifth*, this number multiplied by sec. δ and *sixth* the designation of the authority, where P. MS. stands for DR. PETERS' Ms. and C stands for CHACORNAC'S published charts completed by DR. PETERS.

The counts credited to PROFESSOR WATSON'S maps, Table I. were made by me from his *ms.* maps which are the property of the National Academy of Sciences and are now loaned to the Washburn Observatory. These maps are not in a state for publication, and only a few portions of them are manifestly complete. Such portions I have counted. In all cases the counts serve for 1860.0. Where the epoch of the maps was different allowance has been made for precession.

Nebulæ were omitted from the counts. Close double stars were counted as one star. Wide doubles (30″ and upwards) were counted as two stars.

The counts for Table II. were made by Mr. GEORGE W. BROWN, student in the University, under my direction. They can be verified by consulting Dr. PETERS' published charts. It must be remembered, however, that these charts were printed by photo-lithography, and that there may be a slight difference between each two sets of maps, in the very faintest stars (only). It must also be remembered that the very slight differences named are no more, or even less, than the discrepancies which arise in different counts of the same field in actual gauging.

In a very few cases the numbers of stars counted by me are slightly more than those in the published charts, but in no case is the error material.

Dr. J. PALISA has been so kind as to prepare for me a series of gauges from his own *ms.* maps, which are given in Table III., following this. They include all stars from the brightest down to certain (undetermined) faintest, which could be seen in his two telescopes, viz.: Telescope I, the 6-inch refractor of the observatory of Pola, and Telescope II, the 12-inch refractor of the observatory of Vienna. The table gives, *first*, a current number for reference; *second*, the R. A. and Dec. for 1860 of the center of the space counted; *third*, the telescope with which the map was made; *fourth*, the number of stars laid down in the map within an area of 2m in R. A. by 30′ in Dec. The *fifth* column contains the quantity 4 sec. δ (No. of stars), and expresses the number of stars which would have been mapped in one square degree, provided the distribution of stars over this degree is the same as it is over the 2m in R. A. by 30′ in Decination, which was actually counted.

TABLE I.—COUNTS OF STARS FROM THE MS. CHARTS OF DR. C. H. F. PETERS, PROFESSOR J. C. WATSON, AND FROM CHACORNAC'S CHARTS COMPLETED BY DR. PETERS.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m	° ′			
1	0 2	+ 7 30	53	54	WATSON.
2	0 2	+ 6 30	47	47	WATSON.
3	0 2	+ 0 30	44	44	C.
4	0 2	— 0 30	53	53	C.
5	0 2	— 1 30	41	41	C.
6	0 2	— 2 30	37	37	C.
7	0 2	— 3 30	64	64	C.
8	0 6	+ 7 30	45	45	WATSON.
9	0 6	+ 6 30	49	49	WATSON.
10	0 6	+ 5 30	42	42	C.
11	0 6	+ 4 30	51	51	C.
12	0 6	+ 3 30	47	47	C.
13	0 6	+ 2 30	52	52	C.
14	0 6	+ 1 30	56	56	C.
15	0 6	+ 0 30	49	49	C.
16	0 6	— 0 30	48	48	C.
17	0 6	— 1 30	54	54	C.
18	0 6	— 2 30	58	58	C.
19	0 6	— 3 30	42	42	C.
20	0 10	+ 7 30	43	43	WATSON.
21	0 10	+ 6 30	40	40	WATSON.
22	0 10	+ 5 30	58	58	C.
23	0 10	+ 4 30	42	42	C.
24	0 10	+ 3 30	47	47	C.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars. Sec. δ	Authority.
	h. m.	° ′			
25	0 10	+ 2 30	46	46	C.
26	0 10	+ 1 30	51	51	C.
27	0 10	+ 0 30	57	57	C.
28	0 10	— 0 30	53	53	C.
29	0 10	— 1 30	52	52	C.
30	0 10	— 2 30	70	70	C.
31	0 10	— 3 30	40	40	C.
32	0 14	+ 5 30	69	69	C.
33	0 14	+ 4 30	56	56	C.
34	0 14	+ 3 30	87	87	C.
35	0 14	+ 2 30	48	48	C.
36	0 14	+ 1 30	53	53	C.
37	0 14	+ 0 30	61	61	C.
38	0 14	— 0 30	56	56	C.
39	0 14	— 1 30	37	37	C.
40	0 14	— 2 30	50	50	C.
41	0 14	— 3 30	54	54	C.
42	0 18	+ 5 30	57	57	C.
43	0 18	+ 4 30	80	80	C.
44	0 18	+ 3 30	77	77	C.
45	0 18	+ 2 30	68	68	C.
46	0 18	+ 1 30	50	50	C.
47	0 18	+ 0 30	52	52	C.
48	0 18	— 0 30	49	49	C.
49	0 18	— 1 30	34	34	C.
50	0 18	— 2 30	64	64	C.
51	0 18	— 3 30	63	63	C.
52	0 42	+ 9 30	77	78	C.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
53	0 42	+8 30	85	86	C.
54	0 42	+7 30	64	64	C.
55	0 42	+6 30	69	69	C.
56	0 42	+4 30	42	42	C.
57	0 42	+3 30	50	50	C.
58	0 42	+2 30	44	44	C.
59	0 42	+1 30	40	40	C.
60	0 46	+9 30	67	68	C.
61	0 46	+8 30	58	59	C.
62	0 46	+7 30	71	72	C.
63	0 46	+6 30	74	74	C.
64	0 46	+4 30	59	59	C.
65	0 46	+3 30	49	49	C.
66	0 46	+2 30	46	46	C.
67	0 46	+1 30	55	55	C.
68	0 50	+9 30	79	80	C.
69	0 50	+8 30	63	64	C.
70	0 50	+7 30	66	67	C.
71	0 50	+6 30	64	64	C.
72	0 50	+4 30	70	70	C.
73	0 50	+3 30	61	61	C.
74	0 50	+2 30	51	51	C.
75	0 50	+1 30	56	56	C.
76	0 54	+9 30	77	78	C.
77	0 54	+8 30	78	79	C.
78	0 54	+7 30	63	64	C.
79	0 54	+6 30	72	72	C.
80	0 54	+4 30	66	66	C.

TABLE I.— COUNTS OF STARS — Continued.

No.	R. A. 1860.0	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
81	0 54	+ 3 30	60	60	C.
82	0 54	+ 2 30	50	50	C.
83	0 54	+ 1 30	69	69	C.
84	0 58	+ 9 30	70	71	C.
85	0 58	+ 8 30	62	63	C.
86	0 58	+ 7 30	62	63	C.
87	0 58	+ 6 30	63	63	C.
88	0 58	+ 4 30	56	56	C.
89	0 58	+ 3 30	52	52	C.
90	0 58	+ 2 30	55	55	C.
91	0 58	+ 1 30	54	54	C.
92	1 2	+14 30	80	82	P. Ms.
93	1 2	+13 30	76	78	P. Ms.
94	1 2	+12 30	71	73	P. Ms.
95	1 2	+11 30	73	74	P. Ms.
96	1 2	+10 30	67	68	P. Ms.
97	1 2	+ 4 30	74	74	P. Ms.
98	1 2	+ 3 30	56	56	P. Ms.
99	1 2	+ 2 30	68	68	P. Ms.
100	1 2	+ 1 30	64	64	P. Ms.
101	1 2	+ 0 30	74	74	P. Ms.
102	1 6	+14 30	84	86	P. Ms.
103	1 6	+13 30	87	89	P. Ms.
104	1 6	+12 30	72	73	P. Ms.
105	1 6	+11 30	63	64	P. Ms.
106	1 6	+10 30	69	70	P. Ms.
107	1 6	+ 4 30	90	90	P. Ms.
108	1 6	+ 3 30	76	76	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
109	1 6	+ 2 30	70	70	P. Ms.
110	1 6	+ 1 30	66	66	P. Ms.
111	1 6	+ 0 30	68	68	P. Ms.
112	1 10	+14 30	79	81	P. Ms.
113	1 10	+13 30	81	82	P. Ms.
114	1 10	+12 30	83	85	P. Ms.
115	1 10	+11 30	70	71	P. Ms.
116	1 10	+10 30	76	77	P. Ms.
117	1 10	+ 4 30	67	67	P. Ms.
118	1 10	+ 3 30	62	62	P. Ms.
119	1 10	+ 2 30	67	67	P. Ms.
120	1 10	+ 1 30	70	70	P. Ms.
121	1 10	+ 0 30	68	68	P. Ms.
122	1 14	+14 30	71	73	P. Ms.
123	1 14	+13 30	82	84	P. Ms.
124	1 14	+12 30	75	76	P. Ms.
125	1 14	+11 30	71	72	P. Ms.
126	1 14	+10 30	66	67	P. Ms.
127	1 14	+ 4 30	68	68	P. Ms.
128	1 14	+ 3 30	69	69	P. Ms.
129	1 14	+ 2 30	46	46	P. Ms.
130	1 14	+ 1 30	69	69	P. Ms.
131	1 14	+ 0 30	54	54	P. Ms.
132	1 18	+14 30	64	66	P. Ms.
133	1 18	+13 30	68	70	P. Ms.
134	1 18	+12 30	57	58	P. Ms.
135	1 18	+11 30	68	69	P. Ms.
136	1 18	+10 30	83	84	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
137	1 18	+ 4 30	75	75	P. Ms.
138	1 18	+ 3 30	55	55	P. Ms.
139	1 18	+ 2 30	55	55	P. Ms.
140	1 18	+ 1 30	67	67	P. Ms.
141	1 18	+ 0 30	82	82	P. Ms.
142	1 22	+14 30	73	75	P. Ms.
143	1 22	+13 30	50	51	P. Ms.
144	1 22	+12 30	44	45	P. Ms.
145	1 26	+14 30	58	60	P. Ms.
146	1 26	+13 30	64	66	P. Ms.
147	1 26	+12 30	56	57	P. Ms.
148	1 30	+14 30	42	43	P. Ms.
149	1 30	+13 30	81	83	P. Ms.
150	1 30	+12 30	58	59	P. Ms.
151	1 34	+14 30	59	61	P. Ms.
152	1 34	+13 30	64	66	P. Ms.
153	1 34	+12 30	68	69	P. Ms.
154	1 38	+14 30	53	55	P. Ms.
155	1 38	+13 30	39	40	P. Ms.
156	1 38	+12 30	74	75	P. Ms.
157	1 46	+12 30	69	70	C.
158	1 46	+11 30	61	62	C.
159	1 46	+10 30	65	66	C.
160	1 50	+12 30	67	68	C.
161	1 50	+11 30	91	93	C.
162	1 50	+10 30	58	59	C.
163	1 54	+12 30	71	72	C.
164	1 54	+11 30	68	69	C.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec.	Authority.
	h. m.	° ′			
165	1 54	+10 30	63	64	C.
166	1 58	+12 30	90	92	C.
167	1 58	+11 30	78	79	C.
168	1 58	+10 30	75	76	C.
169	3 2	+19 30	76	80	P. Ms.
170	3 2	+18 30	117	123	P. Ms.
171	3 2	+17 30	89	93	P. Ms.
172	3 2	+16 30	96	100	P. Ms.
173	3 2	+15 30	84	86	P. Ms.
174	3 6	+19 30	70	74	P. Ms.
175	3 6	+18 30	90	95	P. Ms.
176	3 6	+17 30	105	110	P. Ms.
177	3 6	+16 30	73	76	P. Ms.
178	3 6	+15 30	90	94	P. Ms.
179	3 10	+19 30	92	97	P. Ms.
180	3 10	+18 30	87	92	P. Ms.
181	3 10	+17 30	75	79	P. Ms.
182	3 10	+16 30	84	87	P. Ms.
183	3 10	+15 30	86	88	P. Ms.
184	3 14	+19 30	58	60	P. Ms.
185	3 14	+18 30	82	86	P. Ms.
186	3 14	+17 30	64	67	P. Ms.
187	3 14	+16 30	96	100	P. Ms.
188	3 14	+15 30	91	95	P. Ms.
189	3 18	+19 30	62	66	P. Ms.
190	3 18	+18 30	71	75	P. Ms.
191	3 18	+17 30	61	64	P. Ms.
192	3 18	+16 30	86	89	P. Ms.

TABLE I.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
193	3 18	+15 30	91	95	P. Ms.
194	4 2	+23 30	84	91	C.
195	4 2	+22 30	84	90	C.
196	4 2	+21 30	75	80	C.
197	4 2	+20 30	45	47	C.
198	4 2	+19 30	54	57	C.
199	4 6	+23 30	80	87	C.
200	4 6	+22 30	61	66	C.
201	4 6	+21 30	53	57	C.
202	4 6	+20 30	46	49	C.
203	4 6	+19 30	50	53	C.
204	4 10	+23 30	86	94	C.
205	4 10	+22 30	101	109	C.
206	4 10	+21 30	56	60	C.
207	4 10	+20 30	53	56	C.
208	4 10	+19 30	54	57	C.
209	4 14	+23 30	75	81	C.
210	4 14	+22 30	94	101	C.
211	4 14	+21 30	66	71	C.
212	4 14	+20 30	80	85	C.
213	4 14	+19 30	57	60	C.
214	4 18	+23 30	72	78	C.
215	4 18	+22 30	69	74	C.
216	4 18	+21 30	64	68	C.
217	4 18	+20 30	39	42	C.
218	4 18	+19 30	46	49	C.
219	4 42	+24 30	44	48	C.
220	4 42	+23 30	57	62	C.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
221	4 42	+22 30	69	74	C.
222	4 42	+21 30	124	134	C.
223	4 42	+20 30	121	129	C.
224	4 46	+24 30	69	76	C.
225	4 46	+23 30	90	98	C.
226	4 46	+22 30	93	100	C.
227	4 46	+21 30	129	139	C.
228	4 46	+20 30	151	160	C.
229	4 50	+24 30	85	93	C.
230	4 50	+23 30	78	85	C.
231	4 50	+22 30	110	119	C.
232	4 50	+21 30	140	149	C.
233	4 50	+20 30	137	146	C.
234	4 54	+24 30	106	117	C.
235	4 54	+23 30	178	193	C.
236	4 54	+22 30	104	112	C.
237	4 54	+21 30	155	166	C.
238	4 54	+20 30	149	158	C.
239	4 58	+24 30	117	129	C.
240	4 58	+23 30	133	145	C.
241	4 58	+22 30	128	138	C.
242	4 58	+21 30	149	159	C.
243	4 58	+20 30	138	147	C.
244	7 54	+15 30	168	174	P. Ms.
245	7 58	+15 30	84	87	P. Ms.
246	8 26	+20 30	59	63	C.
247	8 26	+19 30	71	75	C.
248	8 26	+18 30	84	88	C.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
249	8 26	+17 30	65	68	C.
250	8 30	+20 30	82	88	C.
251	8 30	+19 30	87	92	C.
252	8 30	+18 30	78	82	C.
253	8 30	+17 30	70	74	C.
254	8 34	+20 30	110	118	C.
255	8 34	+19 30	99	105	C.
256	8 34	+18 30	57	60	C.
257	8 34	+17 30	70	74	C.
258	8 38	+20 30	79	85	C.
259	8 38	+19 30	75	79	C.
260	8 38	+18 30	65	68	C.
261	8 38	+17 30	71	74	C.
262	8 46	+19 30	54	57	C.
263	8 46	+18 30	64	67	C.
264	8 46	+17 30	48	50	C.
265	8 46	+16 30	85	88	C.
266	8 50	+19 30	71	75	C.
267	8 50	+18 30	65	68	C.
268	8 50	+17 30	53	56	C.
269	8 50	+16 30	70	73	C.
270	8 54	+19 30	66	70	C.
271	8 54	+18 30	54	57	C.
272	8 54	+17 30	61	64	C.
273	8 54	+16 30	80	84	C.
274	8 58	+19 30	60	63	C.
275	8 58	+18 30	64	67	C.
276	8 58	+17 30	67	70	C.

TABLE I.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.				
277	8 58	+16 30	69	71	C.
278	9 6	+18 30	52	55	C.
279	9 6	+17 30	66	69	C.
280	9 6	+16 30	65	68	C.
281	9 6	+15 30	60	62	C.
282	9 6	+14 30	68	70	C.
283	9 10	+18 30	61	64	C.
284	9 10	+17 30	62	65	C.
285	9 10	+16 30	64	66	C.
286	9 10	+15 30	65	67	C.
287	9 10	+14 30	63	65	C.
288	9 14	+18 30	53	56	C.
289	9 14	+17 30	58	61	C.
290	9 14	+16 30	59	61	C.
291	9 14	+15 30	61	63	C.
292	9 14	+14 30	68	70	C.
293	9 18	+18 30	55	58	C.
294	9 18	+17 30	63	66	C.
295	9 18	+16 30	53	55	C.
296	9 18	+15 30	67	60	C.
297	9 18	+14 30	50	52	C.
298	9 26	+16 30	60	62	C.
299	9 26	+15 30	62	64	C.
300	9 26	+14 30	83	85	C,
301	9 26	+13 30	61	63	C.
302	9 30	+16 30	57	60	C.
303	9 30	+15 30	57	60	C.
304	9 30	+14 30	55	57	C.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Star	No. Stars Sec. δ	Authority.
	h. m.	° ′			
305	9 30	+13 30	63	65	C.
306	9 34	+16 30	47	49	C.
307	9 34	+15 30	57	59	C.
308	9 34	+14 30	63	65	C.
309	9 34	+13 30	58	60	C.
310	9 38	+16 30	54	56	C.
311	9 38	+15 30	58	60	C.
312	9 38	+14 30	58	60	C.
313	9 38	+13 30	63	65	C.
314	9 42	+ 9 30	61	62	C.
315	9 46	+14 30	64	66	C.
316	9 46	+13 30	78	80	C.
317	9 46	+12 30	54	55	C.
318	9 46	+11 30	65	66	C,
318*a*	9 46	+ 9 30	75	76	C.
319	9 50	+14 30	73	75	C.
320	9 50	+13 30	66	68	C.
321	9 50	+12 30	73	74	C.
322	9 50	+11 30	63	64	C.
323	9 50	+9 30	73	74	C.
324	9 54	+14 30	80	82	C.
325	9 54	+13 30	65	67	C.
326	9 54	+12 30	55	56	C.
327	9 54	+11 30	63	64	C.
328	9 54	+9 30	59	60	P. Ms.
329	9 58	+14 30	62	64	C.
330	9 58	+13 30	49	50	C.
331	9 58	+12 30	46	47	C.
332	9 58	+11 30	69	70	C.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
333	9 58	+ 9 30	71	72	P. Ms.
334	10 2	+14 30	80	82	P. Ms.
335	10 2	+13 30	78	80	P. Ms.
336	10 2	+12 30	80	82	P. Ms.
337	10 2	+11 30	82	84	P. Ms.
338	10 2	+10 30	62	63	P. Ms.
339	10 6	+14 30	75	77	P. Ms.
340	10 6	+13 30	70	72	P. Ms.
341	10 6	+12 30	93	95	P. Ms.
342	10 6	+11 30	84	86	P. Ms.
343	10 6	+10 30	84	86	P. Ms.
344	10 10	+14 30	69	71	P. Ms.
345	10 10	+13 30	91	94	P. Ms.
346	10 10	+12 30	74	75	P. Ms.
347	10 10	+11 30	69	70	P. Ms.
348	10 10	+10 30	68	69	P. Ms.
349	10 14	+14 30	67	69	P. Ms.
350	10 14	+13 30	58	60	P. Ms.
351	10 14	+12 30	85	87	P. Ms.
352	10 14	+11 30	86	88	P. Ms.
353	10 14	+10 30	61	62	P. Ms.
354	10 18	+14 30	72	74	P. Ms.
355	10 18	+13 30	61	63	P. Ms.
356	10 18	+12 30	69	70	P. Ms.
357	10 18	+11 30	85	87	P. Ms.
358	10 18	+10 30	71	72	P. Ms.
359	10 22	+14 30	46	47	P. Ms.
360	10 22	+13 30	59	61	P. Ms.

TABLE I.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
361	10 22	+12 30	47	48	P. Ms.
362	10 26	+14 30	53	54	P. Ms.
363	10 26	+13 30	47	48	P. Ms.
364	10 26	+12 30	57	58	P. Ms.
365	10 30	+14 30	50	51	P. Ms.
366	10 30	+13 30	60	62	P. Ms.
367	10 30	+12 30	55	56	P. Ms.
368	10 34	+14 30	51	53	P. Ms.
369	10 34	+13 30	71	73	P. Ms.
370	10 34	+12 30	51	52	P. Ms.
371	10 38	+14 30	47	48	P. Ms.
372	10 38	+13 30	52	54	P. Ms.
373	10 38	+12 30	64	65	P. Ms.
374	10 42	+14 30	61	63	P. Ms.
375	10 42	+13 30	52	54	P. Ms.
376	10 42	+12 30	50	51	P. Ms.
377	10 46	+14 30	69	71	P. Ms.
378	10 46	+13 30	51	52	P. Ms.
379	10 46	+12 30	64	65	P. Ms.
380	10 50	+14 30	64	66	P. Ms.
381	10 50	+13 30	66	67	P. Ms.
382	10 50	+12 30	72	73	P. Ms.
383	10 54	+14 30	85	87	P. Ms.
384	10 54	+13 30	74	76	P. Ms.
385	10 54	+12 30	73	74	P. Ms.
386	10 58	+14 30	90	93	P. Ms.
387	10 58	+13 30	86	89	P. Ms.
388	10 58	+12 30	100	102	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	′ °			
389	11 2	— 0 30	54	54	P. Ms.
390	11 2	— 1 30	56	56	P. Ms.
391	11 2	— 2 30	47	47	P. Ms.
392	11 2	— 3 30	58	58	P. Ms.
393	11 2	— 4 30	70	70	P. Ms.
394	11 6	+ 7 30	46	46	C.
395	11 6	+ 6 30	47	47	C.
396	11 6	+ 5 30	51	51	C.
397	11 6	+ 4 30	46	46	C.
398	11 6	+ 3 30	51	51	C.
399	11 6	— 0 30	54	54	P. Ms.
400	11 6	— 1 30	64	64	P. Ms.
401	11 6	— 2 30	33	33	P. Ms.
402	11 6	— 3 30	68	68	P. Ms.
403	11 6	— 4 30	63	63	P. Ms.
404	11 10	+ 7 30	46	46	C.
405	11 10	+ 6 30	56	56	C.
406	11 10	+ 5 30	57	57	C.
407	11 10	+ 4 30	42	42	C.
408	11 10	+ 3 30	53	53	C.
409	11 10	— 0 30	45	45	P. Ms.
410	11 10	— 1 30	56	56	P. Ms.
411	11 10	— 2 30	52	52	P. Ms.
412	11 10	— 3 30	75	75	P. Ms.
413	11 10	— 4 30	67	67	P. Ms.
414	11 14	+ 7 30	50	50	C.
415	11 14	+ 6 30	51	51	C.
416	11 14	+ 5 30	76	76	C.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
417	11 14	+ 4 30	49	49	C.
418	11 14	+ 3 30	57	57	C.
419	11 14	— 0 30	45	45	P. Ms.
420	11 14	— 1 30	55	55	P. Ms.
421	11 14	— 2 30	55	55	P. Ms.
422	11 14	— 3 30	67	67	P. Ms.
423	11 14	— 4 30	76	76	P. Ms.
424	11 18	+ 7 30	52	52	C.
425	11 18	+ 6 30	50	50	C.
426	11 18	+ 5 30	37	37	C.
427	11 18	+ 4 30	52	52	C.
428	11 18	+ 3 30	69	69	C.
429	11 18	— 0 30	46	46	P. Ms.
430	11 18	— 1 30	55	55	P. Ms.
431	11 18	— 2 30	54	54	P. Ms.
432	11 18	— 3 30	56	56	P. Ms.
433	11 18	— 4 30	57	57	P. Ms.
434	11 22	— 0 30	51	51	P. Ms.
435	11 22	— 1 30	53	53	P. Ms.
436	11 22	— 2 30	50	50	P. Ms.
437	11 22	— 3 30	58	58	P. Ms.
438	11 22	— 4 30	60	60	P. Ms.
439	11 26	+ 4 30	62	62	C.
440	11 26	+ 3 30	52	52	C.
441	11 26	+ 2 30	57	57	C.
442	11 26	+ 1 30	47	47	C.
443	11 26	— 0 30	66	66	P. Ms.
444	11 26	— 1 30	55	55	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
445	11 26	— 2 30	64	64	P. Ms.
446	11 26	— 3 30	57	57	P. Ms.
447	11 26	— 4 30	65	65	P. Ms.
448	11 30	+ 4 30	55	55	C.
449	11 30	+ 3 30	83	83	C.
450	11 30	+ 2 30	85	85	C.
451	11 30	+ 1 30	56	56	C.
452	11 30	— 0 30	51	51	P. Ms.
453	11 30	— 1 30	60	60	P. Ms.
454	11 30	— 2 30	58	58	P. Ms.
455	11 30	— 3 30	44	44	P. Ms.
456	11 30	— 4 30	45	45	P. Ms.
457	11 34	+ 4 30	66	66	C.
458	11 34	+ 3 30	79	79	C.
459	11 34	+ 2 30	80	80	C.
460	11 34	+ 1 30	42	42	C.
461	11 38	+ 4 30	46	46	C.
462	11 38	+ 3 30	51	51	C.
463	11 38	+ 2 30	76	76	C.
464	11 38	+ 1 30	63	63	C.
465	11 38	— 0 30	55	55	P. Ms.
466	11 38	— 1 30	46	46	P. Ms.
467	11 38	— 2 30	55	55	P. Ms.
468	11 38	— 3 30	57	57	P. Ms.
469	11 38	— 4 30	48	48	P. Ms.
470	11 42	+ 9 30	46	46	P. Ms.
471	11 42	+ 8 30	62	63	P. Ms.
472	11 42	+ 7 30	67	68	P. Ms.
473	11 42	+ 6 30	71	72	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
474	11 42	+ 5 30	43	43	P. Ms.
475	11 42	— 2 30	58	58	P. Ms.
476	11 42	— 3 30	56	56	P. Ms.
477	11 42	— 4 30	57	57	P. Ms.
478	11 46	+ 9 30	60	61	P. Ms.
479	11 46	+ 8 30	58	59	P. Ms.
480	11 46	+ 7 30	51	51	P. Ms.
481	11 46	+ 6 30	64	64	P. Ms.
482	11 46	+ 5 30	57	57	P. Ms.
483	11 46	+ 4 30	73	73	P. Ms.
484	11 46	— 2 30	64	64	P. Ms.
485	11 46	— 3 30	52	52	P. Ms.
486	11 46	— 4 30	58	58	P. Ms.
487	11 50	+ 9 30	56	57	P. Ms.
488	11 50	+ 8 30	56	57	P. Ms.
489	11 50	+ 7 30	45	45	P. Ms.
490	11 50	+ 6 30	60	60	P. Ms.
491	11 50	+ 5 30	62	62	P. Ms.
492	11 50	+ 4 30	61	61	P. Ms.
493	11 50	— 2 30	42	42	P. Ms.
494	11 50	— 3 30	60	60	P. Ms.
495	11 50	— 4 30	55	55	P. Ms.
496	11 54	+ 9 30	60	61	P. Ms.
497	11 54	+ 8 30	62	63	P. Ms.
498	11 54	+ 7 30	76	77	P. Ms.
499	11 54	+ 6 30	63	63	P. Ms.
500	11 54	+ 5 30	48	48	P. Ms
501	11 54	+ 4 30	69	69	P. Ms.

TABLE I.— COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
502	11 54	— 2 30	56	56	P. Ms.
503	11 54	— 3 30	43	43	P. Ms.
504	11 54	— 4 30	45	45	P. Ms.
505	11 58	+ 9 30	57	58	P. Ms.
506	11 58	+ 8 30	60	61	P. Ms.
507	11 58	+ 7 30	49	49	P. Ms.
508	11 58	+ 6 30	70	71	P. Ms.
509	11 58	+ 5 30	57	57	P. Ms.
510	11 58	+ 4 30	55	55	P. Ms.
511	11 58	— 2 30	53	53	P. Ms.
512	11 58	— 3 30	53	53	P. Ms.
513	11 58	— 4 30	47	47	P. Ms.
514	12 2	+ 9 30	58	59	P. Ms.
515	12 2	+ 8 30	58	59	P. Ms.
516	12 2	+ 7 30	66	67	P. Ms.
517	12 2	+ 6 30	54	54	P. Ms.
518	12 2	+ 5 30	52	52	P. Ms.
519	12 2	+ 4 30	58	58	P. Ms.
520	12 2	+ 3 30	70	70	P. Ms.
521	12 2	+ 2 30	67	67	P. Ms.
522	12 2	+ 1 30	57	57	P. Ms.
523	12 2	+ 0 30	64	64	P. Ms.
524	12 2	— 0 30	52	52	P. Ms.
525	12 2	— 1 30	65	65	P. Ms.
526	12 2	— 2 30	51	51	P. Ms.
527	12 2	— 3 30	46	46	P. Ms.
528	12 2	— 4 30	54	54	P. Ms.
529	12 6	+ 9 30	58	59	P. Ms.

TABLE I.— COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
530	12 6	+ 8 30	58	59	P. Ms.
531	12 6	+ 7 30	60	61	P. Ms.
532	12 6	+ 6 30	69	69	P. Ms.
533	12 6	+ 5 30	56	56	P. Ms.
534	12 6	+ 4 30	52	52	P. Ms.
535	12 6	+ 3 30	56	56	P. Ms.
536	12 6	+ 2 30	56	56	P. Ms.
537	12 6	+ 1 30	62	62	P. Ms.
538	12 6	+ 0 30	57	57	P. Ms.
539	12 6	— 0 30	79	79	P. Ms.
540	12 6	— 1 30	56	56	P. Ms.
541	12 6	— 2 30	60	60	P. Ms.
542	12 6	— 3 30	46	46	P. Ms.
543	12 6	— 4 30	55	55	P. Ms.
544	12 10	+ 9 30	67	68	P. Ms.
545	12 10	+ 8 30	63	64	P. Ms.
546	12 10	+ 7 30	69	70	P. Ms,
547	12 10	+ 6 30	59	59	P. Ms.
548	12 10	+ 5 30	74	74	P. Ms.
549	12 10	+ 4 30	43	43	P. Ms.
550	12 10	+ 3 30	59	59	P. Ms.
551	12 10	+ 2 30	59	59	P. Ms.
552	12 10	+ 1 30	58	58	P. Ms.
553	12 10	+ 0 30	59	59	P. Ms.
554	12 10	— 0 30	71	71	P. Ms.
555	12 10	— 1 30	64	64	P. Ms.
556	12 10	— 2 30	54	54	P. Ms.
557	12 10	— 3 30	45	45	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
558	12 10	—4 30	68	68	P. Ms.
559	12 14	+9 30	52	53	P. Ms.
560	12 14	+8 30	79	80	P. Ms.
561	12 14	+7 30	58	59	P. Ms.
562	12 14	+6 30	67	67	P. Ms.
563	12 14	+5 30	67	67	P. Ms.
564	12 14	+4 30	48	48	P. Ms.
565	12 14	+3 30	45	45	P. Ms.
556	12 14	+2 30	59	59	P. Ms.
567	12 14	+1 30	55	55	P. Ms.
568	12 14	+0 30	68	68	P. Ms.
569	12 14	—0 30	61	61	P. Ms.
570	12 14	—1 30	74	74	P. Ms.
571	12 14	—2 30	67	67	P. Ms.
572	12 14	—3 30	47	47	P. Ms.
573	12 14	—4 30	55	55	P. Ms.
574	12 18	+9 30	67	68	P. Ms.
575	12 18	+8 30	70	71	P. Ms.
576	12 18	+7 30	53	53	P. Ms.
577	12 18	+6 30	67	67	P. Ms.
578	12 18	+5 30	66	66	P. Ms.
579	12 18	+4 30	48	48	P. Ms.
580	12 18	+3 30	51	51	P. Ms.
581	12 18	+2 30	48	48	P. Ms.
582	12 18	+1 30	66	66	P. Ms.
583	12 18	+0 30	73	73	P. Ms.
584	12 18	—0 30	74	74	P. Ms.
585	12 18	—1 30	61	61	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
586	12 18	— 2 30	52	52	P. Ms.
587	12 18	— 3 30	54	54	P. Ms.
588	12 18	— 4 30	58	58	P. Ms.
589	12 22	— 0 30	62	62	P. Ms.
590	12 26	— 0 30	63	63	P. Ms.
591	12 30	— 0 30	52	52	P. Ms.
592	12 34	— 0 30	53	53	P. Ms.
593	12 38	— 0 30	63	63	P. Ms.
594	12 46	+ 1 30	50	50	C.
595	12 46	+ 0 30	57	57	C.
596	12 50	+ 1 30	57	57	C.
597	12 50	+ 0 30	74	74	C.
598	13 22	— 5 30	55	55	P. Ms.
599	13 26	— 5 30	79	79	P. Ms.
600	13 30	— 5 30	76	76	P. Ms.
601	13 34	— 5 30	75	75	P. Ms.
602	13 38	— 5 30	65	65	P. Ms.
603	13 42	—10 30	72	73	P. Ms.
604	13 42	—11 30	68	69	P. Ms.
605	13 42	—12 30	77	79	P. Ms.
606	13 42	—13 30	62	64	P. Ms.
607	13 42	—14 30	56	58	P. Ms.
608	13 46	—10 30	66	67	P. Ms.
609	13 46	—11 30	79	81	P. Ms.
610	13 46	—12 30	71	73	P. Ms.
611	13 46	—13 30	76	78	P. Ms.
612	13 46	—14 30	73	75	P. Ms.
613	13 50	—10 30	68	69	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
614	13 50	−11 30	83	85	P. Ms.
615	13 50	−12 30	80	82	P. Ms.
616	13 50	−13 30	75	77	P. Ms.
617	13 50	−14 30	63	65	P. Ms.
618	13 54	−10 30	68	69	P. Ms.
619	13 54	−11 30	70	71	P. Ms.
620	13 54	−12 30	73	74	P. Ms.
621	13 54	−13 30	72	74	P. Ms.
622	13 54	−14 30	85	87	P. Ms.
623	13 58	−10 30	68	69	P. Ms.
624	13 58	−11 30	74	75	P. Ms.
625	13 58	−12 30	67	68	P. Ms.
626	13 58	−13 30	82	84	P. Ms.
627	13 58	−14 30	100	103	P. Ms.
628	14 2	−10 30	85	87	P. Ms.
629	14 2	−11 30	81	83	P. Ms.
630	14 2	−12 30	96	98	P. Ms.
631	14 2	−13 30	71	73	P. Ms.
632	14 2	−14 30	88	90	P. Ms.
633	14 6	−10 30	93	95	P. Ms.
634	14 6	−11 30	79	81	P. Ms.
635	14 6	−12 30	68	69	P. Ms.
636	14 6	--13 30	83	85	P. Ms.
637	14 6	−14 30	94	97	P. Ms.
638	14 10	−10 30	65	66	P. Ms.
639	14 10	−11 30	92	94	P. Ms.
640	14 10	−12 30	76	78	P. Ms.
641	14 10	−13 30	75	77	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
642	14 10	—14 30	77	79	P. Ms.
643	14 14	—10 30	68	69	P. Ms.
644	14 14	—11 30	74	75	P. Ms.
645	14 14	—12 30	68	69	P. Ms.
646	14 14	—13 30	71	73	P. Ms.
647	14 14	—14 30	87	89	P. Ms.
648	14 18	—10 30	77	78	P. Ms.
649	14 18	—11 30	91	93	P. Ms.
650	14 18	—12 30	96	98	P. Ms.
651	14 18	—13 30	88	90	P. Ms.
652	14 18	—14 30	100	103	P. Ms.
653	15 14	—12 30	74	80	WATSON.
654	15 18	—21 30	91	98	WATSON.
655	15 22	—20 30	99	106	P. Ms.
656	15 26	—20 30	88	94	P. Ms.
657	15 30	—20 30	86	92	P. Ms.
658	15 34	—20 30	94	100	P. Ms.
659	15 38	—20 30	86	92	P. Ms.
660	15 42	—20 30	100	107	P. Ms.
661	15 46	—20 30	78	83	P. Ms.
662	15 50	—20 30	96	103	P. Ms.
663	15 54	—20 30	104	111	P. Ms.
664	15 58	—20 30	100	107	P. Ms.
665	16 6	+15 30	61	63	WATSON.
666	16 10	+15 30	75	78	WATSON.
667	16 14	+15 30	69	72	WATSON.
668	16 22	+16 30	85	88	WATSON.
669	16 26	+16 30	90	94	WATSON.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
670	16 30	+16 30	88	92	WATSON,
671	19 2	—22 30	164	177	P. Ms.
672	19 2	—25 30	174	193	P. Ms.
673	19 6	—22 30	162	174	P. Ms.
674	19 6	—25 30	169	188	P, Ms.
675	19 10	—22 30	173	186	P. Ms.
676	19 10	—25 30	169	188	P. Ms.
677	19 14	—22 30	211	228	P. Ms.
678	19 14	—25 30	186	207	P. Ms.
679	19 18	—22 30	210	227	P. Ms.
680	19 18	—25 30	212	235	P. Ms.
681	20 2	— 5 30	108	108	P. Ms.
682	20 6	— 5 30	106	106	P. Ms.
683	20 10	— 5 30	151	151	P. Ms.
684	20 14	— 5 30	158	158	P. Ms.
685	20 18	— 5 30	139	139	P. Ms.
686	20 22	— 5 30	122	122	P. Ms.
687	20 26	— 5 30	99	99	P. Ms.
688	20 30	— 5 30	82	82	P. Ms.
689	20 34	— 5 30	92	92	P. Ms.
690	20 38	— 5 30	90	90	P. Ms.
691	20 42	— 5 30	79	79	P. Ms.
692	20 46	— 5 30	86	86	P. Ms.
693	20 50	— 5 30	74	74	P. Ms.
694	20 54	— 5 30	66	66	P. Ms.
695	20 58	— 5 30	86	86	P. Ms.
696	21 2	—20 30	65	69	P. Ms.
697	21 2	—21 30	85	91	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
698	21 2	—22 30	90	97	P. Ms.
699	21 2	—23 30	81	88	P. Ms.
700	21 2	—24 30	70	77	P. Ms.
701	21 2	—25 30	96	108	WATSON.
702	21 6	—20 30	80	86	P. Ms.
703	21 6	—21 30	74	79	P. Ms.
704	21 6	—22 30	85	92	P. Ms.
705	21 6	—23 30	62	67	P. Ms.
706	21 6	—24 30	65	72	P. Ms.
707	21 10	—20 30	85	91	P. Ms.
708	21 10	—21 30	85	91	P. Ms.
709	21 10	—22 30	110	119	P. Ms.
710	21 10	—23 30	89	97	P. Ms.
711	21 10	—24 30	66	73	P. Ms.
712	21 14	—20 30	79	84	P. Ms.
713	21 14	—21 30	68	73	P. Ms.
714	21 14	—22 30	89	96	P. Ms.
715	21 14	—23 30	87	95	P. Ms.
716	21 14	—24 30	48	53	P. Ms.
717	21 18	—20 30	66	71	P. Ms.
718	21 18	—21 30	82	88	P. Ms.
719	21 18	—22 30	67	72	P. Ms.
720	21 18	—23 30	50	55	P. Ms.
721	21 18	—24 30	53	58	P. Ms.
722	21 22	—11 30	80	82	P. Ms.
723	21 22	—12 30	95	97	P. Ms.
724	21 22	—13 30	85	87	P. Ms.
725	21 22	—14 30	88	91	P. Ms.

TABLE I.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
726	21 22	—15 30	82	85	P. Ms.
727	21 22	—16 30	73	76	P. Ms.
728	21 22	—17 30	145	152	P. Ms.
729	21 22	—18 30	84	88	P. Ms.
730	21 22	—19 30	73	77	P. Ms.
731	21 26	—10 30	96	98	P. Ms.
732	21 26	—11 30	97	99	P. Ms.
733	21 26	—12 30	90	92	P. Ms.
734	21 26	—13 30	107	110	P. Ms.
735	21 26	—14 30	106	109	P. Ms.
736	21 26	—15 30	78	81	P. Ms.
737	21 26	—16 30	68	71	P. Ms.
738	21 26	—17 30	88	92	P. Ms.
739	21 26	—18 30	88	92	P. Ms.
740	21 26	—19 30	89	94	P. Ms.
741	21 30	—10 30	94	96	P. Ms.
742	21 30	—11 30	94	96	P. Ms.
743	21 30	—12 30	98	100	P. Ms.
744	21 30	—13 30	89	92	P. Ms.
745	21 30	—14 30	106	109	P. Ms.
746	21 30	—15 30	73	76	P. Ms.
747	21 30	—16 30	64	66	P. Ms.
748	21 30	—17 30	83	87	P. Ms.
749	21 30	—18 30	79	83	P. Ms.
750	21 30	—19 30	80	85	P. Ms.
751	21 34	—10 30	98	100	P. Ms.
752	21 34	—11 30	107	109	P. Ms.
753	21 34	—12 30	92	94	P. Ms.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars. Sec. δ	Authority.
	h. m.	° ′			
754	21 34	—13 30	94	97	P. Ms.
755	21 34	—14 30	95	98	P. Ms.
756	21 34	—15 30	71	74	P. Ms.
757	21 34	—16 30	90	94	P. Ms.
758	21 34	—17 30	78	82	P. Ms.
759	21 34	—18 30	73	77	P. Ms.
760	21 34	—19 30	85	90	P. Ms.
761	21 38	—10 30	90	92	P. Ms.
762	21 38	—11 30	84	86	P. Ms.
763	21 38	—12 30	77	79	P. Ms.
764	21 38	—13 30	108	111	P. Ms.
765	21 38	—14 30	84	86	P. Ms.
766	21 38	—15 30	69	72	P. Ms.
767	21 38	—16 30	80	83	P. Ms.
768	21 38	—17 30	80	84	P. Ms.
769	21 38	—18 30	77	81	P. Ms.
770	21 38	—19 30	79	84	P. Ms.
771	21 42	—10 30	91	93	P. Ms.
772	21 42	—11 30	80	82	P. Ms.
773	21 42	—12 30	86	88	P. Ms.
774	21 42	—13 30	142	145	P. Ms.
775	21 42	—14 30	92	95	P. Ms.
776	21 42	—15 30	52	54	P. Ms.
777	21 42	—16 30	41	43	P. Ms.
778	21 46	—10 30	87	89	P. Ms.
779	21 46	—11 30	82	84	P. Ms.
780	21 46	—12 30	86	88	P. Ms.
781	21 46	—13 30	86	88	P. Ms.

TABLE I.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
782	21 46	—14 30	87	90	P. Ms.
783	21 46	—15 30	56	58	P. Ms.
784	21 50	—10 30	88	90	P. Ms.
785	21 50	—11 30	106	108	P, Ms.
786	21 50	—12 30	93	95	P. Ms.
787	21 50	—13 30	83	85	P. Ms.
788	21 50	—14 30	82	84	P. Ms.
789	21 50	—15 30	61	63	P. Ms.
790	21 54	—10 30	99	101	P. Ms.
791	21 54	—11 30	100	102	P. Ms.
792	21 54	—12 30	105	107	P. Ms.
793	21 54	—13 30	78	80	P. Ms.
794	21 54	—14 30	83	85	P. Ms.
795	21 54	—15 30	58	60	P. Ms.
796	21 58	—10 30	83	85	P. Ms.
797	21 58	—11 30	114	116	P. Ms.
798	21 58	—12 30	91	93	P. Ms.
799	21 58	—13 30	92	95	P. Ms.
800	21 58	—14 30	79	81	P. Ms.
801	21 58	—15 30	57	59	P. Ms.
802	22 2	— 5 30	84	84	P. Ms.
803	22 2	— 6 30	70	70	P. Ms.
804	22 2	— 7 30	48	48	P. Ms.
805	22 2	— 8 30	69	70	P. Ms.
806	22 2	— 9 30	77	78	P. Ms.
807	22 2	—10 30	83	85	P. Ms.
808	22 2	—11 30	70	71	P. Ms.
809	22 2	—12 30	86	88	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
810	22 2	—13 30	82	84	P. Ms.
811	22 2	—14 30	97	100	P. Ms.
812	22 6	— 5 30	94	94	P. Ms.
813	22 6	— 6 30	98	98	P. Ms.
814	22 6	— 7 30	57	57	P. Ms.
815	22 6	— 8 30	79	80	P. Ms.
816	22 6	— 9 30	91	92	P. Ms.
817	22 6	—10 30	74	75	P. Ms.
818	22 6	—11 30	60	61	P. Ms.
819	22 6	—12 30	82	84	P. Ms.
820	22 6	—13 30	89	92	P. Ms.
821	22 6	—14 30	73	75	P. Ms.
822	22 10	— 5 30	68	68	P. Ms.
823	22 10	— 6 30	84	84	P. Ms.
824	22 10	— 7 30	68	69	P. Ms.
825	22 10	— 8 30	69	70	P. Ms.
826	22 10	— 9 30	80	81	P. Ms.
827	22 10	—10 30	65	66	P. Ms.
828	22 10	—11 30	81	83	P. Ms.
829	22 10	—12 30	90	92	P. Ms.
830	22 10	—13 30	91	94	P. Ms.
831	22 10	—14 30	87	90	P. Ms.
832	22 14	— 5 30	64	64	P. Ms.
833	22 14	— 6 30	67	67	P. Ms.
834	22 14	— 7 30	63	64	P. Ms.
835	22 14	— 8 30	67	68	P. Ms.
836	22 14	— 9 30	76	77	P. Ms.
837	22 14	—10 30	55	56	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m	° ′			
838	22 14	—11 30	67	68	P. Ms.
839	22 14	—12 30	75	76	P. Ms.
840	22 14	—13 30	92	95	P. Ms.
841	22 14	—14 30	80	82	P. Ms.
842	22 18	— 5 30	85	85	P. Ms.
843	22 18	— 6 30	74	74	P. Ms.
844	22 18	— 7 30	84	85	P. Ms.
845	22 18	— 8 30	76	77	P. Ms.
846	22 18	— 9 30	68	69	P. Ms.
847	22 18	—10 30	65	66	P. Ms.
848	22 18	—11 30	60	61	P. Ms.
849	22 18	—12 30	67	68	P. Ms.
850	22 18	—13 30	84	86	P. Ms.
851	22 18	—14 30	76	78	P. Ms.
852	22 22	— 5 30	78	78	P. Ms.
853	22 22	— 6 30	80	80	P. Ms.
854	22 22	— 7 30	70	71	P. Ms.
855	22 22	— 8 30	69	70	P. Ms.
856	22 22	— 9 30	50	51	P. Ms.
857	22 26	— 5 30	62	62	P. Ms.
858	22 26	— 6 30	75	75	P. Ms.
859	22 26	— 7 30	80	81	P. Ms.
860	22 26	— 8 30	59	60	P. Ms.
861	22 26	— 9 30	70	71	P. Ms.
862	22 30	— 5 30	51	51	P. Ms.
863	22 30	— 6 30	82	82	P. Ms.
864	22 30	— 7 30	62	63	P. Ms.
865	22 30	— 8 30	66	67	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m	° ′			
866	22 30	— 9 30	40	40	P. Ms.
867	22 34	— 5 30	67	67	P. Ms.
868	22 34	— 6 30	73	73	P. Ms.
869	22 34	— 7 30	70	71	P. Ms.
870	22 34	— 8 30	64	65	P. Ms.
871	22 34	— 9 30	54	55	P. Ms.
872	22 38	— 5 30	48	48	P. Ms.
873	22 38	— 6 30	50	50	P. Ms.
874	22 38	— 7 30	68	69	P. Ms.
875	22 38	— 8 30	64	65	P. Ms.
876	22 38	— 9 30	60	61	P. Ms.
877	22 42	— 5 30	54	54	P. Ms.
878	22 42	— 6 30	47	47	P. Ms.
879	22 42	— 7 30	62	63	P. Ms.
880	22 42	— 8 30	59	60	P. Ms.
881	22 42	— 9 30	65	66	P. Ms.
882	22 46	— 5 30	61	61	P. Ms.
883	22 46	— 6 30	52	52	P. Ms.
884	22 46	— 7 30	61	62	P. Ms.
885	22 46	— 8 30	55	56	P. Ms.
886	22 46	— 9 30	60	61	P. Ms.
887	22 50	— 5 30	52	52	P. Ms.
888	22 50	— 6 30	47	47	P. Ms.
889	22 50	— 7 30	72	73	P. Ms.
890	22 50	— 8 30	78	79	P. Ms.
891	22 50	— 9 30	66	67	P. Ms.
892	22 54	— 5 30	46	46	P. Ms.
893	22 54	— 6 30	61	61	P. Ms.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
894	22 54	— 7 30	63	64	P. Ms.
895	22 54	— 8 30	64	65	P. Ms.
896	22 54	— 9 30	72	73	P. Ms.
897	22 58	— 5 30	50	50	P. Ms.
898	22 58	— 6 30	60	60	P. Ms.
899	22 58	— 7 30	52	52	P. Ms.
900	22 58	— 8 30	60	61	P. Ms.
901	22 58	— 9 30	63	64	P. Ms.
902	23 2	+ 1 30	71	71	P. Ms.
903	23 2	+ 0 30	86	86	P. Ms.
904	23 2	— 0 30	66	66	WATSON.
905	23 2	— 1 30	71	71	WATSON.
906	23 2	— 6 30	70	70	C.
907	23 6	+ 1 30	93	93	P. Ms.
908	23 6	+ 0 30	79	79	P. Ms.
909	23 6	— 0 30	64	64	WATSON.
910	23 6	— 1 30	76	76	WATSON.
911	23 6	— 5 30	53	53	C.
912	23 6	— 6 30	55	55	C.
913	23 10	+ 1 30	82	82	P. Ms.
914	23 10	+ 0 30	85	85	P. Ms.
915	23 10	— 4 30	67	67	C.
916	23 10	— 5 30	53	53	C.
917	23 14	+ 0 30	67	67	P. Ms.
918	23 14	— 4 30	65	65	C.
919	23 14	— 5 30	55	55	C.
920	23 14	— 8 30	56	57	WATSON.
921	23 14	—10 30	61	62	WATSON.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars. Sec. δ	Authority.
	h. m.	° ′			
922	23 18	+ 0 30	59	59	P. Ms.
923	23 18	— 4 30	42	42	C.
924	23 18	— 5 30	41	41	C.
925	23 18	— 8 30	68	69	WATSON.
926	23 18	— 9 30	51	52	WATSON.
927	23 18	—10 30	60	61	WATSON.
928	23 22	+ 1 30	62	62	P. Ms.
929	23 22	+ 0 30	68	68	P. Ms.
930	23 22	— 1 30	52	52	C.
931	23 22	— 2 30	44	44	C.
932	23 22	— 3 30	52	52	C.
933	23 22	— 4 30	51	51	C.
934	23 26	+ 1 30	66	66	P. Ms.
935	23 26	+ 0 30	40	40	P. Ms.
936	23 26	— 1 30	38	38	C.
937	23 26	— 2 30	46	46	C.
938	23 26	— 3 30	59	59	C.
939	23 26	— 4 30	52	52	C.
940	23 30	+ 1 30	72	72	P. Ms.
941	23 30	+ 0 30	52	52	P. Ms.
942	23 30	— 1 30	48	48	C.
943	23 30	— 2 30	48	48	C.
944	23 30	— 3 30	54	54	C.
945	23 30	— 4 30	61	61	C.
946	23 34	+ 1 30	68	68	P. Ms.
947	23 34	+ 0 30	42	42	P. Ms.
948	23 34	— 1 30	47	47	C.
949	23 34	— 2 30	56	56	C.

TABLE I—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
950	23 34	— 3 30	71	71	C.
951	23 34	— 4 30	56	56	C.
952	23 38	+ 1 30	74	74	P. Ms.
953	23 38	+ 0 30	50	50	P. Ms.
954	23 38	— 1 30	33	33	C.
955	23 38	— 2 30	49	49	C.
956	23 38	— 3 30	50	50	C.
957	23 38	— 4 30	50	50	C.
958	23 42	+ 0 30	42	42	C.
959	23 42	— 0 30	58	58	C.
960	23 42	— 1 30	57	57	C.
961	23 42	— 2 30	50	50	C.
962	23 46	+ 0 30	63	63	C.
963	23 46	— 0 30	74	74	C.
964	23 46	— 1 30	42	42	C.
965	23 46	— 2 30	76	76	C.
966	23 50	+ 7 30	45	45	WATSON.
967	23 50	+ 6 30	49	49	WATSON.
968	23 50	+ 0 30	73	73	C.
969	23 50	— 0 30	65	63	C.
970	23 50	— 1 30	76	76	C.
971	23 50	— 2 30	79	79	C.
972	23 54	+ 7 30	62	63	WATSON.
973	23 54	+ 6 30	62	62	WATSON.
974	23 54	+ 0 30	69	69	C.
975	23 54	— 0 30	76	76	C.
976	23 54	— 1 30	57	57	C.
977	23 54	— 2 30	57	57	C.

TABLE I — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	Authority.
	h. m.	° ′			
978	23 58	+ 7 30	53	53	WATSON.
979	23 58	+ 6 30	61	61	WATSON.
980	23 58	+ 0 30	65	65	C.
981	23 58	— 0 30	62	62	C.
982	23 58	— 1 30	52	52	C.
983	23 58	— 2 30	48	48	C.

TABLE II.— COUNTS OF STARS FROM THE PUBLISHED CHARTS OF DR. C. H. F. PETERS. NOS. 1–20.

No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars Sec. δ	No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars Sec. δ
	h.	m.	°	′				h.	m.	°	′		
1	1	2	+14	30	86	88	26	1	10	+ 4	30	76	76
2	1	2	+13	30	88	90	27	1	10	+ 3	30	84	84
3	1	2	+12	30	74	76	28	1	10	+ 2	30	83	83
4	1	2	+11	30	84	86	29	1	10	+ 1	30	78	78
5	1	2	+10	30	83	85	30	1	10	+ 0	30	72	72
6	1	2	+ 4	30	85	85	31	1	14	+14	30	97	100
7	1	2	+ 3	30	79	79	32	1	14	+13	30	99	102
8	1	2	+ 2	30	77	77	33	1	14	+12	30	78	79
9	1	2	+ 1	30	75	75	34	1	14	+11	30	88	90
10	1	2	+ 0	30	91	91	35	1	14	+10	30	82	83
11	1	6	+14	30	93	96	36	1	14	+ 4	30	89	89
12	1	6	+13	30	98	101	37	1	14	+ 3	30	88	88
13	1	6	+12	30	86	88	38	1	14	+ 2	30	77	77
14	1	6	+11	30	76	78	39	1	14	+ 1	30	79	79
15	1	6	+10	30	88	90	40	1	14	+ 0	30	61	61
16	1	6	+ 4	30	109	109	41	1	18	+14	30	79	81
17	1	6	+ 3	30	86	86	42	1	18	+13	30	93	96
18	1	6	+ 2	30	86	86	43	1	18	+12	30	90	92
19	1	6	+ 1	30	75	75	44	1	18	+11	30	86	88
20	1	6	+ 0	30	77	77	45	1	18	+10	30	88	90
21	1	10	+14	30	83	85	46	1	18	+ 4	30	87	87
22	1	10	+13	30	90	93	47	1	18	+ 3	30	89	89
23	1	10	+12	30	94	96	48	1	18	+ 2	30	81	81
24	1	10	+11	30	76	77	49	1	18	+ 1	30	76	76
25	1	10	+10	30	99	101	50	1	18	+ 0	30	92	92

TABLE II.— COUNTS OF STARS — Continued.

No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars Sec. δ	No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars Sec. δ
	h.	m.	°	′				h.	m.	°	′		
51	3	2	+19	30	99	105	78	10	2	+12	30	85	87
52	3	2	+18	30	119	125	79	10	2	+11	30	78	80
53	3	2	+17	30	101	106	80	10	2	+10	30	68	69
54	3	2	+16	30	106	110	81	10	6	+14	30	87	90
55	3	2	+15	30	104	108	82	10	6	+13	30	75	77
56	3	6	+19	30	90	95	83	10	6	+12	30	97	99
57	3	6	+18	30	110	116	84	10	6	+11	30	84	86
58	3	6	+17	30	117	123	85	10	6	+10	30	83	85
59	3	6	+16	30	93	97	86	10	10	+14	30	70	72
60	3	6	+15	30	99	103	87	10	10	+13	30	96	99
61	3	10	+19	30	110	117	88	10	10	+12	30	74	75
62	3	10	+18	30	123	129	89	10	10	+11	30	73	74
63	3	10	+17	30	107	112	90	10	10	+10	30	71	72
64	3	10	+16	30	109	113	91	10	14	+14	30	71	73
65	3	10	+15	30	106	109	92	10	14	+13	30	61	63
66	3	14	+19	30	105	111	93	10	14	+12	30	90	92
67	3	14	+18	30	107	112	94	10	14	+11	30	86	88
68	3	14	+17	30	104	109	95	10	14	+10	30	64	65
69	3	14	+16	30	118	122	96	10	18	+14	30	76	78
70	3	14	+15	30	99	103	97	10	18	+13	30	78	80
71	3	18	+19	30	117	124	98	10	18	+12	30	72	73
72	3	18	+18	30	102	107	99	10	18	+11	30	98	100
73	3	18	+17	30	112	118	100	10	18	+10	30	80	82
74	3	18	+16	30	114	118	101	10	22	+14	30	74	76
75	3	18	+15	30	104	108	102	10	22	+13	30	85	87
76	10	2	+14	30	81	83	103	10	22	+12	30	75	76
77	10	2	+13	30	87	89	104	10	22	+11	30	72	73

TABLE II—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ
	h. m.	° ′				h. m.	° ′		
105	10 22	+10 30	82	83	132	10 46	+13 30	63	65
106	10 26	+14 30	93	96	133	10 46	+12 30	84	86
107	10 26	+13 30	67	69	134	10 46	+11 30	94	96
108	10 26	+12 30	84	86	135	10 46	+10 30	81	83
109	10 26	+11 30	81	83	136	10 50	+14 30	70	72
110	10 26	+10 30	84	86	137	10 50	+13 30	73	75
111	10 30	+14 30	78	80	138	10 50	+12 30	79	81
112	10 30	+13 30	87	89	138	10 50	+11 30	72	73
113	10 30	+12 30	83	85	140	10 50	+10 30	65	66
114	10 30	+11 30	86	88	141	10 54	+14 30	81	83
115	10 30	+10 30	81	82	142	10 54	+13 30	78	80
116	10 34	+14 30	85	87	143	10 54	+12 30	81	83
117	10 34	+13 30	81	83	144	10 54	+11 30	75	76
118	10 34	+12 30	78	80	145	10 54	+10 30	73	74
119	10 34	+11 30	86	88	146	10 58	+14 30	90	92
120	10 34	+10 30	92	94	147	10 58	+13 30	97	100
121	10 38	+14 30	73	75	148	10 58	+12 30	95	97
122	10 38	+13 30	83	85	149	10 58	+11 30	66	67
123	10 38	+12 30	83	85	150	10 58	+10 30	78	79
124	10 38	+11 30	77	78	151	11 2	— 0 30	67	67
125	10 38	+10 30	76	77	152	11 2	— 1 30	64	64
126	10 42	+14 30	77	79	153	11 2	— 2 30	60	60
127	10 42	+13 30	69	71	154	11 2	— 3 30	65	65
128	10 42	+12 30	63	64	155	11 2	— 4 30	74	74
129	10 42	+11 30	73	74	156	11 6	— 0 30	78	78
130	10 42	+10 30	67	68	157	11 6	— 1 30	86	86
131	10 46	+14 30	89	91	158	11 6	— 2 30	62	62

TABLE II—COUNTS OF STARS—Continued.

No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars, Sec. δ	No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars, Sec. δ
	h.	m.	°	′				h.	m.	°	′		
159	11	6	−3	30	66	66	186	11	50	+9	30	71	72
160	11	6	−4	30	66	66	187	11	50	+8	30	71	72
161	11	10	−0	30	64	64	188	11	50	+7	30	68	69
162	11	10	−1	30	76	76	189	11	50	+6	30	75	75
163	11	10	−2	30	78	78	190	11	50	+5	30	81	81
164	11	10	−3	30	76	76	191	11	54	+9	30	67	68
165	11	10	−4	30	71	71	192	11	54	+8	30	75	76
166	11	14	−0	30	60	60	193	11	54	+7	30	85	86
167	11	14	−1	30	78	78	194	11	54	+6	30	84	84
168	11	14	−2	30	73	73	195	11	54	+5	30	67	67
169	11	14	−3	30	75	75	196	11	58	+9	30	67	68
170	11	14	−4	30	81	81	197	11	58	+8	30	66	67
171	11	18	−0	30	68	68	198	11	58	+7	30	60	61
172	11	18	−1	30	71	71	199	11	58	+6	30	81	81
173	11	18	−2	30	68	68	200	11	58	+5	30	76	76
174	11	18	−3	30	59	59	201	12	2	+9	30	59	60
175	11	18	−4	30	63	63	202	12	2	+8	30	64	65
176	11	42	+9	30	61	62	203	12	2	+7	30	81	82
177	11	42	+8	30	79	80	204	12	2	+6	30	60	60
178	11	42	+7	30	81	82	205	12	2	+5	30	61	61
179	11	42	+6	30	91	92	206	12	2	−0	30	54	54
180	11	42	+5	30	53	53	207	12	2	−1	30	75	75
181	11	46	+9	30	76	77	208	12	2	−2	30	63	63
182	11	46	+8	30	77	78	209	12	2	−3	30	55	55
183	11	46	+7	30	65	66	210	12	2	−4	30	61	61
184	11	46	+6	30	74	74	211	12	6	+9	30	58	59
185	11	46	+5	30	81	81	212	12	6	+8	30	66	67

TABLE II.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ.
	h. m.	° ′				h. m.	° ′		
213	12 6	+ 7 30	75	76	240	12 14	— 4 30	56	56
214	12 6	+ 6 30	87	88	241	12 18	+ 9 30	66	67
215	12 6	+ 5 30	67	67	242	12 18	+ 8 30	68	69
216	12 6	— 0 30	84	84	243	12 18	+ 7 30	70	71
217	12 6	— 1 30	59	59	244	12 18	+ 6 30	75	75
218	12 6	— 2 30	69	69	245	12 18	+ 5 30	68	68
219	12 6	— 3 30	53	53	246	12 18	— 0 30	76	76
220	12 6	— 4 30	58	58	247	12 18	— 1 30	67	67
221	12 10	+ 9 30	65	66	248	12 18	— 2 30	71	71
222	12 10	+ 8 30	69	70	249	12 18	— 3 30	77	77
223	12 10	+ 7 30	73	74	250	12 18	— 4 30	80	80
224	12 10	+ 6 30	69	69	251	12 22	— 0 30	72	72
225	12 10	+ 5 30	77	77	252	12 22	— 1 30	79	79
226	12 10	— 0 30	74	74	253	12 22	— 2 30	64	64
227	12 10	— 1 30	70	70	254	12 22	— 3 30	80	80
228	12 10	— 2 30	67	67	255	12 22	— 4 30	67	67
229	12 10	— 3 30	58	58	256	12 26	— 0 30	72	72
230	12 10	— 4 30	76	76	257	12 26	— 1 30	70	70
231	12 14	+ 9 30	55	56	258	12 26	— 2 30	54	54
232	12 14	+ 8 30	86	87	259	12 26	— 3 30	63	63
233	12 14	+ 7 30	76	77	260	12 26	— 4 30	60	60
234	12 14	+ 6 30	74	74	261	12 30	— 0 30	61	61
235	12 14	+ 5 30	66	66	262	12 30	— 1 30	79	79
236	12 14	— 0 30	63	63	263	12 30	— 2 30	100	100
237	12 14	— 1 30	79	79	264	12 30	— 3 30	55	55
238	12 14	— 2 30	83	83	265	12 30	— 4 30	73	73
239	12 14	— 3 30	79	79	266	12 34	— 0 30	56	56

TABLE II.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ	No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ
	h. m.	° ′				h. m.	° ′		
267	12 34	— 1 30	76	76	294	14 14	—13 30	76	78
268	12 34	— 2 30	64	64	295	14 14	—14 30	86	88
269	12 34	— 3 30	68	68	296	14 18	—10 30	79	81
270	12 34	— 4 30	77	77	297	14 18	—11 30	92	94
271	12 38	— 0 30	73	73	298	14 18	—12 30	99	101
272	12 38	— 1 30	65	65	299	14 18	—13 30	106	109
273	12 38	— 2 30	74	74	300	14 18	--14 30	109	112
274	12 38	— 3 30	70	70	301	21 2	—20 30	89	95
275	12 38	— 4 30	70	70	302	21 2	—21 30	109	117
276	14 2	—10 30	101	103	303	21 2	—22 30	105	113
277	14 2	—11 30	92	94	304	21 2	—23 30	87	95
278	14 2	—12 30	106	108	305	21 2	—24 30	74	81
279	14 2	—13 30	78	80	306	21 6	—20 30	100	107
280	14 2	—14 30	102	105	307	21 6	—21 30	93	99
281	14 6	—10 30	103	105	308	21 6	—22 30	93	100
282	14 6	—11 30	86	88	309	21 6	—23 30	90	98
283	14 6	—12 30	97	99	310	21 6	--24 30	82	90
284	14 6	—13 30	90	92	311	21 10	—20 30	95	102
285	14 6	—14 30	101	104	312	21 10	—21 30	94	100
286	14 10	—10 30	77	79	313	21 10	—22 30	108	115
287	14 10	—11 30	101	103	314	21 10	—23 30	96	104
288	14 10	—12 30	79	81	315	21 10	—24 30	99	109
289	14 10	—13 30	104	107	316	21 14	—20 30	89	96
290	14 10	—14 30	84	86	317	21 14	—21 30	83	89
291	14 14	—10 30	80	82	318	21 14	—22 30	94	101
292	14 14	—11 30	75	77	319	21 14	—23 30	102	111
293	14 14	—12 30	78	80	320	21 14	—24 30	96	106

TABLE II — COUNTS OF STARS — Continued.

No.	R. A. 1860		Dec. 1860.		No. Stars.	No. Stars Sec. δ	No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars Sec. δ
	h.	m.	°	′				h.	m.	°	′		
321	21	18	—20	30	79	85	348	21	30	—12	30	99	101
322	21	18	—21	30	94	102	349	21	30	—13	30	103	106
323	21	18	—22	30	78	84	350	21	30	—14	30	105	108
324	21	18	—23	30	86	94	351	21	30	—15	30	95	99
325	21	18	—24	30	91	100	352	21	30	—16	30	96	100
326	21	22	—10	30	119	121	353	21	30	—17	30	99	108
327	21	22	—11	30	84	86	354	21	30	—18	30	90	95
328	21	22	—12	30	109	111	355	21	30	—19	30	103	109
329	21	22	—13	30	95	98	356	21	34	—10	30	98	100
330	21	22	—14	30	100	103	357	21	34	—11	30	120	122
331	21	22	—15	30	93	97	358	21	34	—12	30	101	103
332	21	22	—16	30	96	100	359	21	34	—13	30	99	102
333	21	22	—17	30	142	149	360	21	34	—14	30	106	109
334	21	22	—18	30	89	93	261	21	34	—15	30	93	97
335	21	22	—19	30	83	88	362	21	34	—16	30	116	120
336	21	26	—10	30	100	102	363	21	34	—17	30	98	103
337	21	26	—11	30	108	110	364	21	34	—18	30	109	114
338	21	26	—12	30	114	116	365	21	34	—19	30	106	112
339	21	26	—13	30	112	115	366	21	38	—10	30	105	107
340	21	26	—14	30	116	119	367	21	38	—11	30	109	111
341	21	26	—15	30	101	105	368	21	38	—12	30	104	106
342	21	26	—16	30	101	105	389	21	38	—13	30	118	121
343	21	26	—17	30	97	102	370	21	38	—14	30	91	94
344	21	26	—18	30	110	116	371	21	38	—15	30	97	101
345	21	26	—19	30	115	123	372	21	38	—16	30	108	112
346	21	30	—10	30	107	109	373	21	38	—17	30	103	108
347	21	30	—11	30	103	105	374	21	38	—18	30	107	112

TABLE II—COUNTS OF STARS—Continued.

No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars. Sec. δ	No.	R. A. 1860.		Dec. 1860.		No. Stars.	No. Stars Sec. δ
	h.	m.	°	′				h.	m.	°	′		
375	21	38	—19	30	93	98	402	21	50	—16	30	86	89
375	21	42	—10	30	100	102	403	21	50	—17	30	79	83
377	21	42	—11	30	82	84	404	21	50	—18	30	98	103
378	21	42	—12	30	92	94	405	21	50	—19	30	100	106
379	21	42	—13	30	132	135	406	21	54	—10	30	97	99
380	21	42	—14	30	96	99	407	21	54	—11	30	99	101
381	21	42	—15	30	80	83	408	21	54	—12	30	110	112
382	21	42	—16	30	95	99	409	21	54	—13	30	93	96
383	21	42	—17	30	92	97	410	21	54	—14	30	102	105
384	21	42	—18	30	114	120	411	21	54	—15	30	93	97
385	21	42	—19	30	98	104	412	21	54	—16	30	99	103
386	21	46	—10	30	101	103	413	21	54	—17	30	95	100
387	21	46	—11	30	90	92	414	21	54	—18	30	106	111
388	21	46	—12	30	91	93	415	21	54	—19	30	98	104
389	21	46	—13	30	107	110	416	21	58	—10	30	87	89
390	21	46	—14	30	89	92	417	21	58	—11	30	97	99
391	21	46	—15	30	88	91	418	21	58	—12	30	103	105
392	21	46	—16	30	99	103	419	21	58	—13	30	92	95
393	21	46	—17	30	100	105	420	21	58	—14	30	91	94
394	21	46	—18	30	95	100	421	21	58	—15	30	75	78
395	21	46	—19	30	89	94	422	21	58	—16	30	112	116
396	21	50	—10	30	108	110	423	21	58	—17	30	80	84
397	21	50	—11	30	114	116	424	21	58	—18	30	103	108
398	21	50	—12	30	95	97	425	21	58	—19	30	97	103
399	21	50	—13	30	93	95	426	22	2	— 5	30	86	86
400	21	50	—14	30	83	85	427	22	2	— 6	30	81	81
401	21	50	—15	30	90	94	428	22	2	— 7	30	52	52

TABLE II — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars, Sec. δ	No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars, Sec. δ
	h. m.	° ′				h. m.	° ′		
429	22 2	—8 30	81	82	456	22 26	—5 30	84	84
430	22 2	—9 30	86	87	457	22 26	—6 30	92	92
431	22 6	—5 30	96	96	458	22 26	—7 30	105	106
432	22 6	—6 30	99	100	459	22 26	—8 30	90	91
433	22 6	—7 30	80	81	460	22 26	—9 30	106	107
434	22 6	—8 30	93	94	461	22 30	—5 30	79	79
435	22 6	—9 30	90	91	462	22 30	—6 30	105	106
436	22 10	—5 30	67	67	463	22 30	—7 30	83	84
437	22 10	—6 30	86	86	464	22 30	—8 30	102	103
438	22 10	—7 30	77	78	465	22 30	—9 30	74	75
439	22 10	—8 30	76	77	466	22 34	—5 30	111	111
440	22 10	—9 30	84	85	467	22 34	—6 30	93	94
441	22 14	—5 30	68	68	468	22 34	—7 30	82	83
442	22 14	—6 30	74	74	469	22 34	—8 30	97	98
443	22 14	—7 30	74	75	470	22 34	—9 30	101	102
444	22 14	—8 30	79	80	471	22 38	—5 30	86	86
445	22 14	—9 30	90	91	472	22 38	—6 30	89	89
446	22 18	—5 30	94	94	473	22 38	—7 30	118	119
447	22 18	—6 30	82	82	474	22 38	—8 30	103	104
448	22 18	—7 30	93	94	475	22 38	—9 30	108	109
449	22 18	—8 30	87	88	476	22 42	—5 30	113	113
450	22 18	—9 30	86	87	477	22 42	—6 30	111	111
451	22 22	—5 30	108	108	478	22 42	—7 30	96	97
452	22 22	—6 30	91	91	479	22 42	—8 30	89	90
453	22 22	—7 30	76	77	480	22 42	—9 30	114	115
454	22 22	—8 30	105	106	481	22 46	—5 30	115	115
455	22 22	—9 30	95	96	482	22 46	—6 30	90	91

TABLE II — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	No. Stars.	No Stars Sec. δ	No.	R. A. 1860.	Dec. 1860.	No. Stars.	No. Stars Sec. δ
	h. m.	° ′				h. m.	° ′		
483	22 46	— 7 30	87	88	492	22 54	— 6 30	93	94
484	22 46	— 8 30	82	83	493	22 54	— 7 30	95	96
485	22 46	— 9 30	91	92	494	22 54	— 8 30	96	97
486	22 50	— 5 30	83	83	495	22 54	— 9 30	97	98
487	22 50	— 6 30	82	82	496	22 58	— 5 30	80	80
488	22 50	— 7 30	113	114	497	22 58	— 6 30	78	78
489	22 50	— 8 30	96	97	498	22 58	— 7 30	82	83
490	22 50	— 9 30	93	94	499	22 58	— 8 30	86	87
491	22 54	— 5 30	74	74	500	22 58	— 9 30	85	86

TABLE III – COUNTS OF STARS FROM THE ECLIPTIC CHARTS OF DR. J. PALISA.

(I = 6 inch telescope; II = 12 inch telescope.)

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
1	0 1 0	+ 8 45	I	16	65
2	0 1 0	+ 8 15	I	27	109
3	0 1 0	+ 7 45	I	19	77
4	0 3 0	+ 8 45	I	27	109
5	0 3 0	+ 8 15	I	30	121
6	0 3 0	—11 30	II	36	147
7	0 3 0	—15 45	II	20	187
8	0 4 0	— 8 15	I	15	61
9	0 5 0	+ 8 30	I	24	97
10	0 5 0	—11 15	II	20	82
11	0 5 0	—15 30	II	15	62
12	0 6 0	— 8 15	I	25	101
13	0 6 0	—10 45	II	25	102
14	0 7 0	—15 15	II	20	83
15	0 8 0	— 7 0	I	15	61
16	0 8 0	— 7 45	I	20	81
17	0 8 0	— 8 15	I	30	121
18	0 9 0	+ 9 15	I	21	85
19	0 9 0	—14 45	II	27	111
20	0 10 0	— 7 0	I	14	57
21	0 11 0	— 8 0	I	17	69
22	0 13 0	— 7 30	I	18	73
23	0 13	—14 15	II	23	95
24	0 14 0	+ 9 15	I	11	44
25	0 14 0	+ 8 45	I	21	85

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
26	0 14 0	+ 8 15	I	12	48
27	0 14 0	+ 7 45	I	9	36
28	0 14 0	— 6 45	I	20	81
29	0 14 0	—12 45	II	23	94
30	0 15 0	+ 7 15	I	20	81
31	0 15 0	— 7 15	I	17	69
32	0 15 0	—14 0	II	26	105
33	0 16 0	+ 9 15	I	23	93
34	0 16 0	+ 8 45	I	26	105
35	0 16 0	+ 8 15	I	13	53
36	0 16 0	+ 7 45	I	12	48
37	0 17 0	—13 30	II	15	61
38	0 18 0	+ 8 30	I	16	65
39	0 18 0	+ 8 0	I	19	77
40	0 18 0	+ 7 30	I	8	32
41	0 19 0	—12 45	II	28	114
42	0 19 0	—13 15	II	29	119
43	0 20 0	+ 8 30	I	15	61
44	1 32 0	+ 6 15	I & II	17	69
45	1 33 0	+ 4 45	I & II	32	129
46	1 34 0	+ 6 15	I & II	23	93
47	1 34 0	+ 5 45	I & II	18	73
48	1 35 0	+ 5 15	I & II	29	117
49	1 36 0	+ 6 15	I & II	19	77
50	1 36 0	+ 5 45	I & II	22	89
51	1 37 0	+ 5 15	I & II	26	105
52	1 38 0	+ 6 15	I & II	18	73
53	1 38 0	+ 5 45	I & II	26	105

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ. × No.
	h. m. s.	° ′			
54	1 40 0	+6 45	I & II	21	85
55	1 40 0	+6 15	I & II	17	69
56	1 40 0	+5 45	I & II	17	68
57	1 42 0	+6 45	I & II	29	117
58	1 42 0	+6 15	I & II	39	157
59	1 42 0	+5 45	I & II	22	89
60	1 43 0	+8 15	I & II	17	69
61	1 44 0	+6 45	I & II	25	101
62	1 44 0	+6 15	I & II	24	97
63	1 44 0	+5 45	I & II	25	101
64	1 45 0	+8 15	I & II	18	73
65	1 45 0	+7 15	I & II	27	109
66	1 46 0	+6 45	I & II	25	101
67	1 46 0	+6 15	I & II	14	56
68	1 47 0	+8 15	I & II	15	64
69	1 47 0	+7 15	I & II	23	93
70	1 48 0	+6 45	I & II	20	81
71	1 48 0	+6 15	I & II	22	89
72	1 49 0	+7 15	I & II	27	109
73	1 50 0	+6 45	I & II	12	48
74	1 51 0	+7 45	I & II	28	113
75	1 51 0	+7 15	I & II	15	60
76	1 52 0	+6 45	I & II	31	125
77	1 52 0	−1 0	I	21	84
78	1 53 0	+8 15	I & II	23	92
79	1 53 0	+7 45	I & II	21	85
80	1 53 0	+7 15	I & II	15	61
81	1 53 0	0 0	I	15	60

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
82	1 54 0	— 0 30	I	19	76
83	1 54 0	— 1 0	I	17	68
84	1 55 0	+ 8 45	I & II	34	137
85	1 55 0	+ 8 15	I & II	21	85
86	1 55 0	+ 7 45	I & II	13	52
87	1 55 0	+ 7 15	I & II	22	89
88	1 55 0	— 0 0	I	19	76
89	1 56 0	— 1 15	I	25	100
90	1 57 0	+ 8 45	I & II	23	93
91	1 57 0	+ 7 45	I & II	19	77
92	1 57 0	+ 7 15	I & II	14	56
93	1 57 0	— 1 45	I	26	104
94	1 58 0	— 1 15	I	23	92
95	1 59 0	+ 8 45	I & II	21	85
96	1 59 0	+ 7 45	I & II	24	97
97	1 59 0	+ 7 15	I & II	20	81
98	1 59 0	— 1 45	I	17	68
99	2 3 0	+ 9 45	II	22	89
100	2 3 0	+ 7 45	I	21	85
101	2 3 0	+ 7 15	I	21	85
102	2 5 0	+10 0	II	27	100
103	2 5 0	+ 7 45	I	18	73
104	2 5 0	+ 7 15	I	14	56
105	2 7 0	+10 0	II	20	81
106	2 7 0	+ 7 45	I	14	56
107	2 7 0	+ 7 15	I	10	40
108	2 9 0	+ 7 45	I	20	81
109	2 11 0	+ 8 15	I	16	65

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
110	2 11 0	+ 7 45	I	25	101
111	2 13 0	+ 8 15	I	18	73
112	2 13 0	+ 7 45	I	18	73
113	2 15 0	+ 8 45	I	15	61
114	2 15 0	+ 8 15	I	15	61
115	2 17 0	+ 8 45	I	15	61
116	2 19 0	+ 8 45	I	12	48
117	2 21 0	+ 9 15	I	25	101
118	2 21 0	+ 8 45	I	21	85
119	2 21 0	+ 8 15	I	23	93
120	2 22 0	+ 6 30	I	24	97
121	2 23 0	+ 9 15	I	26	105
122	2 23 0	+ 8 45	I	18	73
123	2 23 0	+ 8 15	I	24	97
124	2 25 0	+10 15	I	21	86
125	2 25 0	+ 9 45	I	26	105
126	2 25 0	+ 9 15	I	19	77
127	2 25 0	+ 8 45	I	20	81
128	2 26 0	+ 6 45	I	22	89
129	2 27 0	+10 15	I	27	110
130	2 27 0	+ 9 45	I	13	53
131	2 27 0	+ 9 15	I	24	97
132	2 27 0	+ 8 45	I	19	77
133	2 28 0	+ 6 45	I	22	89
134	2 29 0	+10 15	I	22	90
135	2 29 0	+ 9 45	I	25	101
136	2 29 0	+ 9 15	I	21	85
137	2 29 0	+ 8 45	I	10	40

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
138	2 31 0	+21 45	I	23	99
139	2 31 0	+21 15	I	26	111
140	2 31 0	+20 45	I	27	114
141	2 31 0	+10 15	I	21	86
142	2 31 0	+ 9 45	I	22	89
143	2 31 0	+ 9 15	I	21	85
144	2 31 0	+ 8 45	I	21	85
145	2 33 0	+21 45	I	18	78
146	2 33 0	+21 15	I	20	86
147	2 33 0	+20 45	I	37	158
148	2 33 0	+10 45	I	19	78
149	2 33 0	+10 15	I	13	53
150	2 33 0	+ 9 45	I	23	93
151	2 33 0	+ 9 15	I	18	73
152	2 33 0	+ 8 45	I	15	61
153	2 35 0	+21 15	I	12	51
154	2 35 0	+11 15	I	26	106
155	2 35 0	+10 45	I	16	65
156	2 35 0	+10 15	I	18	73
157	2 35 0	+ 9 45	I	23	93
158	2 35 0	+ 9 15	I	10	40
159	2 35 0	+ 8 45	I	18	73
160	2 37 0	+11 15	I	22	90
161	2 37 0	+10 45	I	27	110
162	2 37 0	+10 15	I	15	61
163	2 37 0	+ 9 45	I	21	85
164	2 37 0	+ 9 15	I	17	69
165	2 37 0	+ 8 45	I	13	

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.			Dec. 1860.		Telescope.	No. Stars.	4 Sec. δ × No.
	h.	m.	s.	°	′			
166	2	39	0	+11	15	I	25	102
167	2	39	0	+10	45	I	20	82
168	2	39	0	+10	15	I	19	77
169	2	39	0	+ 9	45	I	13	53
170	2	41	0	+11	15	I	22	90
171	2	41	0	+10	45	I	21	86
172	2	41	0	+10	15	I	19	77
173	2	41	0	+ 9	45	I	25	101
174	2	43	0	+19	45	I	31	131
175	2	43	0	+11	15	I	20	82
176	2	43	0	+10	45	I	19	77
177	2	43	0	+10	15	I	22	90
178	2	43	0	+ 9	45	I	13	53
179	2	45	0	+19	45	I	24	102
180	2	45	0	+19	15	I	26	110
181	2	45	0	+11	15	I	20	82
182	2	45	0	+10	45	I	18	73
183	2	45	0	+10	15	I	14	57
184	2	47	0	+19	15	I	16	68
185	2	47	0	+11	15	I	12	49
186	2	47	0	+10	15	I	14	57
187	2	49	0	+19	15	I	13	55
188	2	49	0	+11	15	I	14	57
189	2	51	0	+19	15	I	19	81
190	2	53	0	+19	15	I	17	72
191	2	55	0	+19	15	I	26	110
192	2	57	0	+19	15	I	23	97
193	2	59	0	+19	15	I	15	64

TABLE III — COUNTS OF STARS — Continued.

No	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars	4 Sec. δ ×No.
	h. m. s.	° ′			
194	3 1 0	+19 45	II	31	131
195	3 1 0	+19 15	II	26	110
196	3 1 0	+18 45	II	45	190
197	3 1 0	+18 15	II	28	118
198	3 1 0	+17 45	II	29	122
199	3 1 0	+17 15	II	23	97
200	3 1 0	+12 0	I	18	73
201	3 3 0	+19 45	II	20	85
202	3 3 0	+19 15	II	25	106
203	3 3 0	+18 45	II	44	186
204	3 3 0	+18 15	II	38	149
205	3 3 0	+17 45	II	31	130
206	3 3 0	+12 0	I	10	41
207	3 5 0	+18 45	II	42	178
208	3 5 0	+18 15	II	36	151
209	3 5 0	+17 45	II	33	138
210	3 5 0	+12 15	I	15	61
211	3 7 0	+12 15	I	18	73
212	3 9 0	+12 15	I	10	41
213	3 11 0	+19 30	II	35	153
214	3 11 0	+12 15	I	14	57
215	3 13 0	+19 30	II	34	144
216	3 13 0	+12 30	I	15	61
217	3 15 0	+19 30	II	30	127
218	3 15 0	+12 30	I	11	45
219	3 17 0	+19 45	II	34	144
220	3 19 0	+19 45	II	31	131
221	3 21 0	+8 30	I	26	105

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
222	3 22 0	+20 0	II	17	72
223	3 23 0	+ 8 30	I	14	57
224	3 24 0	+20 15	II	46	194
225	3 25 0	+ 8 30	I	11	45
226	3 26 0	+20 15	II	38	161
227	3 26 0	+18 0	II	32	134
228	3 27 0	+ 8 30	I	11	44
229	3 28 0	+18 0	II	18	79
230	3 29 0	+ 8 30	I	12	48
231	3 31 0	+19 30	I	21	89
232	3 32 0	+ 8 45	I	12	48
233	3 33 0	+19 30	I	25	106
234	3 34 0	+20 0	I	15	64
235	3 34 0	+ 8 45	I	16	65
236	3 35 0	+19 30	I	28	119
237	3 36 0	+20 0	I	23	97
238	3 36 0	+ 8 45	I	22	89
239	3 37 0	+19 30	I	34	144
240	3 38 0	+20 0	I	35	148
241	3 38 0	+ 8 45	I	24	97
242	3 39 0	+19 30	I	26	110
243	3 40 0	+20 0	I	20	85
244	3 40 0	+ 8 45	I	16	65
245	3 46 0	+20 15	I	28	119
246	3 47 0	+19 45	I	24	102
247	3 48 0	+20 15	I	25	106
248	3 49 0	+19 45	I	22	93
249	3 50 0	+20 15	I	22	93

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
250	3 51 0	+20 45	I	45	191
251	3 51 0	+19 45	I	27	114
252	3 52 0	+20 15	I	23	97
253	3 53 0	+20 45	I	25	106
254	3 55 0	+20 45	I	34	145
255	3 57 0	+21 0	I	31	132
256	3 59 0	+21 0	I	30	128
257	4 2 0	+ 9 45	I	22	89
258	4 4 0	+10 0	I	26	106
259	4 6 0	+10 15	I	25	102
260	4 8 0	+10 30	I	23	94
261	4 10 0	+10 45	I	23	94
262	4 12 0	+11 0	I	20	82
263	4 14 0	+11 30	I	33	135
264	4 16 0	+11 45	I	23	94
265	4 18 0	+12 0	I	30	122
266	4 24 0	+13 15	I	18	74
267	4 25 0	+12 15	I	34	139
268	4 26 0	+13 15	I	29	119
269	4 27 0	+12 30	I	31	126
270	4 28 0	+13 15	I	25	102
271	4 29 0	+12 45	I	39	160
272	4 30 0	+13 15	I	24	99
273	4 31 0	+21 30	I	25	107
274	4 32 0	+13 15	I	32	132
275	4 33 0	+21 30	I	23	99
276	4 34 0	+13 15	I	32	132
277	4 35 0	+21 45	I	24	104

TABLE III.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
278	4 36 0	+13 15	I	16	66
279	4 37 0	+21 45	I	22	95
280	4 39 0	+22 15	I	24	104
281	4 39 0	+21 45	I	18	78
282	4 41 0	+13 30	I	28	115
283	4 43 0	+13 30	I	24	99
284	4 48 0	+13 45	I	23	95
285	4 50 0	+13 45	I	30	124
286	4 52 0	+13 45	I	30	124
287	4 54 0	+13 45	I	27	111
288	4 56 0	+13 45	I	33	136
289	4 58 0	+13 45	I	39	161
290	5 0 0	+13 45	I	38	157
291	5 41 0	+15 0	I	42	174
292	5 43 0	+15 0	I	54	224
293	5 45 0	+15 15	I	57	237
294	5 47 0	+15 15	I	73	304
295	5 51 0	+16 15	I	41	170
296	5 53 0	+16 30	I	29	120
297	6 21 0	+28 0	I	63	285
298	6 21 0	+27 30	I	67	289
299	6 30 0	+28 15	I	71	320
300	6 33 0	+27 15	I	63	284
301	6 40 0	+23 15	I	75	324
302	6 42 0	+23 15	I	71	309
303	6 44 0	+23 15	I	63	274
304	6 46 0	+23 7.5	I	77	335
305	6 48 0	+23 7.5	I	84	365
306	6 50 0	+23 7.5	I	69	300

TABLE III.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
307	6 52 0	+23 0	I	97	423
308	6 54 0	+23 0	I	92	401
309	7 22 0	+22 30	I	32	138
310	7 24 0	+22 30	I	42	181
311	7 26 0	+22 30	I	41	177
312	7 28 0	+22 30	I	38	164
313	7 30 0	+22 30	I	55	238
314	7 32 0	+22 30	I	49	212
315	7 41 0	+29 0	II	43	196
316	7 43 0	+29 0	II	44	201
317	7 44 0	+26 30	I	44	197
318	7 44 0	+26 0	I	36	149
319	7 44 0	+19 30	I	44	186
320	7 45 0	+29 0	II	53	241
321	7 46 0	+26 30	I	42	188
322	7 46 0	+26 0	I	30	133
323	7 46 0	+19 30	I	39	165
324	7 47 0	+29 0	II	49	224
325	7 48 0	+26 30	I	52	233
326	7 48 0	+19 15	I	47	199
327	7 49 0	+29 0	II	34	155
328	7 50 0	+26 30	I	35	157
329	7 50 0	+19 15	I	53	225
330	7 51 0	+29 0	II	37	170
331	7 52 0	+26 30	I	37	166
332	7 53 0	+29 0	II	36	164
333	7 54 0	+26 30	I	31	141
334	7 54 0	+ 8 30	I	52	210

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars	4 Sec. δ × No.
	h. m. s.	° ′			
335	7 55 0	+29 0	II	40	182
336	7 56 0	+ 8 30	I	39	158
337	7 57 0	+29 0	II	40	182
338	7 58 0	+19 15	I	40	170
339	7 58 0	+ 8 30	I	45	342
340	7 59 0	+29 0	II	34	155
341	7 59 0	+19 45	I	23	99
342	8 0 0	+19 15	I	27	114
343	8 1 0	+29 30	II	49	225
344	8 1 0	+22 15	II	59	154
345	8 1 0	+21 45	II	44	190
346	8 1 0	+21 15	II	53	229
347	8 1 0	+20 45	II	50	214
348	8 1 0	+20 15	II	46	197
349	8 1 0	+19 45	II	56	237
350	8 1 0	+19 15	II	59	250
351	8 1 0	+18 45	II	62	262
352	8 1 0	+18 15	II	47	199
353	8 1 0	+17 45	II	58	243
354	8 3 0	+22 15	II	58	250
355	8 3 0	+21 45	II	55	238
356	8 3 0	+21 15	II	52	224
357	8 3 0	+20 45	II	66	282
358	8 3 0	+20 15	II	54	231
359	8 3 0	+19 45	II	61	259
360	8 3 0	+18 15	II	56	235
361	8 3 0	+17 45	II	47	197
362	8 5 0	+22 15	II	48	207

TABLE III.—COUNTS OF STARS—Continued.

No	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
363	8 5 0	+21 45	II	53	229
364	8 5 0	+21 15	II	49	209
365	8 5 0	+20 45	II	53	227
366	8 5 0	+20 15	II	41	174
367	8 5 0	+19 45	II	59	250
368	8 6 0	+ 9 15	I	50	202
369	8 10 0	+ 1 0	I	51	204
370	8 12 0	+ 1 0	I	47	188
371	8 14 0	+ 9 0	I	43	174
372	8 14 0	+ 0 45	I	61	244
373	8 16 0	+ 9 0	I	39	158
374	8 16 0	+ 0 30	I	43	172
375	8 42 0	+ 7 15	I	26	105
376	8 44 0	+ 7 15	I	27	109
377	9 14 0	+23 15	I	19	82
378	9 15 0	+24 15	I	10	44
379	9 15 0	+23 45	I	14	61
380	9 16 0	+24 45	I	16	70
381	9 16 0	+23 15	I	18	78
382	9 17 0	+24 15	I	17	77
383	9 17 0	+23 45	I	10	44
384	9 17 0	+22 45	I	17	73
385	9 17 0	+21 45	I	24	104
386	9 18 0	+24 45	I	11	48
387	9 18 0	+23 15	I	21	91
388	9 19 0	+24 15	I	17	75
389	9 19 0	+23 45	I	14	61
390	9 19 0	+22 45	I	18	78

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.			Dec. 1860.		Telescope.	No. Stars.	4 Sec. δ × No.
	h.	m.	s.	°	′			
391	9	19	0	+22	15	I	20	86
392	9	19	0	+21	45	I	14	60
393	9	20	0	+24	45	I	10	44
394	9	20	0	+23	15	I	11	48
395	9	21	0	+24	15	I	15	66
396	9	21	0	+23	45	I	26	113
397	9	21	0	+22	45	I	16	69
398	9	21	0	+22	15	I	10	43
399	9	21	0	+21	45	I	13	56
400	9	21	0	+21	15	I	20	86
401	9	21	0	+ 6	45	I	29	117
402	9	22	0	+24	45	I	19	84
403	9	22	0	+23	15	I	9	39
404	9	23	0	+24	15	I	27	118
405	9	23	0	+23	45	I	13	57
406	9	23	0	+22	45	I	16	69
407	9	23	0	+22	15	I	19	82
408	9	23	0	+21	45	I	11	47
409	9	23	0	+21	15	I	18	77
410	9	23	0	+ 6	45	I	31	73
411	9	24	0	+23	15	I	17	74
412	9	25	0	+24	15	I	12	53
413	9	25	0	+23	45	I	17	74
414	9	25	0	+22	45	I	14	60
415	9	25	0	+22	15	I	15	65
416	9	25	0	+21	15	I	12	51
417	9	25	0	+ 6	45	I	34	137
418	9	26	0	+24	45	I	21	92

TABLE III. — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ. × No.
	h. m. s.	° ′			
419	9 26 0	+23 15	I	11	48
420	9 27 0	+24 15	I	16	70
421	9 27 0	+23 45	I	18	85
422	9 27 0	+22 45	I	16	69
423	9 27 0	+22 15	I	14	60
424	9 27 0	+ 6 30	I	26	105
425	9 28 0	+24 45	I	22	96
426	9 28 0	+23 15	I	24	106
427	9 29 0	+24 15	I	14	62
428	9 29 0	+23 45	I	27	118
429	9 29 0	+22 45	I	20	86
430	9 30 0	+24 45	I	11	48
431	9 30 0	+23 15	I	14	61
432	9 31 0	+24 15	I	19	84
433	9 31 0	+23 45	I	22	96
434	9 31 0	+22 45	I	11	48
435	9 31 0	+22 15	II	13	56
436	9 31 0	+11 30	I	26	106
437	9 32 0	+23 15	I	19	83
438	9 32 0	+11 0	I	28	114
439	9 33 0	+24 15	I	17	75
440	9 33 0	+23 45	I	20	87
441	9 33 0	+22 45	II	17	73
442	9 33 0	+22 15	II	21	91
443	9 33 0	+21 45	II	14	60
444	9 33 0	+11 30	I	21	86
445	9 33 0	+10 30	I	23	94
446	9 33 0	+10 0	I	33	135

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
447	9 34 0	+23 15	I	10	44
448	9 34 0	+21 15	II	20	83
449	9 34 0	+11 0	I	25	102
450	9 35 0	+24 15	I	12	53
451	9 35 0	+22 45	II	17	73
452	9 35 0	+22 15	II	24	104
453	9 35 0	+21 45	II	12	52
454	9 35 0	+ 6 15	I	32	129
455	9 36 0	+21 15	II	16	58
456	9 37 0	+24 15	I	20	88
457	9 37 0	+22 45	II	22	97
458	9 37 0	+22 15	II	18	78
459	9 37 0	+21 45	II	19	81
460	9 37 0	+ 6 15	I	35	141
461	9 38 0	+23 45	II	15	66
462	9 38 0	+23 15	II	20	87
463	9 38 0	+21 15	II	19	63
464	9 39 0	+24 15	II	22	96
465	9 39 0	+22 45	II	22	95
466	9 39 0	+22 15	II	25	108
467	9 39 0	+21 45	II	24	103
468	9 39 0	+ 6 15	I	23	93
469	9 40 0	+23 45	II	20	87
470	9 40 0	+23 15	II	24	106
471	9 40 0	+21 15	II	24	103
472	9 41 0	+ 6 15	I	28	113
473	9 43 0	+ 6 15	I	30	121
474	9 45 0	+ 7 0	I	25	101

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
475	9 45 0	+ 6 15	I	26	105
476	9 47 0	+ 7 0	I	22	89
477	9 49 0	+ 7 0	I	27	109
478	9 50 0	+ 5 45	I	23	93
479	9 52 0	+ 5 45	I	34	137
480	9 54 0	+ 5 45	I	25	101
481	10 8 0	+ 8 45	I	22	89
482	10 8 0	+ 8 15	I	14	57
483	10 8 0	+ 7 45	I	18	73
484	10 9 0	+ 6 45	I	17	69
485	10 10 0	+ 8 45	I	21	84
486	10 10 0	+ 8 15	I	24	97
487	10 10 0	+ 7 45	I	10	40
488	10 10 0	+ 7 15	I	20	81
489	10 11 0	+ 6 45	I	21	85
490	10 12 0	+ 8 45	I	15	61
491	10 12 0	+ 8 15	I	28	113
492	10 12 0	+ 7 45	I	32	125
493	10 12 0	+ 7 15	I	21	85
494	10 13 0	+ 6 45	I	18	73
495	10 14 0	+ 8 15	I	20	81
496	10 14 0	+ 7 45	I	18	73
497	10 14 0	+ 7 15	I	34	137
498	10 14 0	+ 6 15	I	27	109
499	10 15 0	+ 6 45	I	32	129
500	10 16 0	+ 7 45	I	33	133
501	10 16 0	+ 7 15	I	24	97
502	10 16 0	+ 6 15	I	29	117

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
503	10 17 0	+ 6 45	I	17	69
504	10 18 0	+ 7 45	I	28	113
505	10 18 0	+ 7 15	I	21	85
506	10 20 0	+ 7 45	I	23	93
507	10 20 0	+ 7 15	I	25	101
508	10 28 0	+ 6 30	I	16	65
509	10 30 0	+ 6 30	I	24	97
510	10 34 0	+ 5 45	I	16	64
511	10 36 0	+ 5 45	I	21	84
512	10 38 0	+ 5 30	I	18	72
513	10 40 0	+ 5 30	I	11	44
514	11 1 0	+ 9 45	I	22	89
515	11 1 0	— 3 30	I	16	64
516	11 2 0	+15 15	I	16	66
517	11 4 0	+ 9 30	II	23	94
518	11 3 0	— 3 30	I	23	92
519	11 4 0	+15 0	I	14	58
520	11 5 0	+ 9 15	II	25	101
521	11 5 0	+ 8 45	II	17	69
522	11 5 0	— 3 45	I	18	72
523	11 6 0	+14 45	I	14	58
524	11 7 0	+ 8 45	II	35	141
525	11 7 0	— 4 0	I	34	136
526	11 8 0	+14 30	I	10	41
527	11 9 0	+ 8 30	II	23	93
528	11 9 0	— 4 0	I	23	92
529	11 11 0	— 4 15	I	21	84
530	11 13 0	— 4 15	I	18	72

TABLE III.—COUNTS OF STARS—Continued.

No	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
531	11 15 0	+13 15	I	18	74
532	11 15 0	— 4 30	I	23	92
533	11 17 0	+13 15	I	17	70
534	11 17 0	— 4 30	I	23	92
535	11 17 0	— 5 0	I	16	64
536	11 19 0	+13 45	I	19	78
537	11 19 0	+12 45	I	18	74
538	11 19 0	— 4 30	I	21	84
529	11 19 0	— 5 0	I	24	96
540	11 21 0	+13 45	I	18	74
541	11 21 0	+12 45	I	16	66
542	11 21 0	— 4 45	I	14	56
543	11 25 0	— 5 0	I	26	104
544	11 31 0	— 5 30	I	13	52
545	11 33 0	— 5 45	I	20	80
546	11 35 0	— 5 45	I	25	100
547	11 37 0	— 6 0	I	14	56
548	11 39 0	— 6 0	I	15	60
549	12 11 0	— 4 15	II	35	140
550	12 15 0	— 4 30	II	29	116
551	12 17 0	— 4 45	II	27	108
552	12 29 0	— 7 45	II	28	113
553	12 34 0	— 6 45	II	36	145
554	12 35 0	— 6 0	II	25	101
555	12 36 0	— 7 0	II	24	97
556	12 37 0	— 6 0	II	40	161
557	12 39 0	— 6 0	II	35	141
558	12 45 0	— 8 30	II	19	77

TABLE III — COUNTS OF STARS — Continued.

No	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars	4 Sec. δ × No.
	h. m. s.	° ′			
559	12 47 0	— 8 45	II	16	65
560	12 49 0	— 8 15	II	29	117
561	13 2 0	—12 30	I	20	82
562	13 4 0	—12 30	I	23	94
563	13 6 0	—12 45	I	27	110
564	13 8 0	—12 45	I	24	99
565	13 10 0	—13 0	I	27	111
566	13 12 0	—13 0	I	22	91
567	13 14 0	—13 15	I	23	95
568	13 16 0	—13 15	I	17	70
569	13 18 0	—13 30	I	19	78
570	13 20 0	—13 30	I	14	58
571	13 22 0	+12 30	I	27	110
572	13 24 0	+12 15	I	20	82
573	13 24 0	+11 45	I	13	53
574	13 25 0	—13 45	I	21	86
575	13 27 0	—14 0	I	14	58
576	13 29 0	—14 0	I	14	58
577	13 31 0	—14 15	I	9	37
578	13 32 0	+10 30	I	16	65
579	13 33 0	+11 30	I	13	53
580	13 33 0	+11 0	I	12	49
581	13 33 0	—14 15	I	20	82
582	13 34 0	+10 30	I	18	73
583	13 35 0	+11 30	I	21	86
584	13 35 0	+11 0	I	21	86
585	13 35 0	—14 15	I	23	95
586	13 37 0	+11 30	I	13	54

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.			Dec. 1860.		Telescope.	No. Stars.	4 Sec. δ × No.
	h.	m.	s.	°	′			
587	13	37	0	+11	0	I	12	49
588	13	39	0	+11	0	I	16	65
589	13	44	0	−14	45	I	14	58
590	13	46	0	−14	45	I	16	66
591	13	48	0	−15	0	I	17	70
592	15	49	0	−14	45	I	17	70
593	15	49	0	−15	15	I	16	66
594	15	51	0	−14	45	I	18	74
595	15	53	0	−14	45	I	17	69
596	15	53	0	−15	15	I	11	46
597	16	2	0	− 6	0	I	28	113
598	16	2	0	− 7	0	I	17	69
499	16	2	0	− 7	30	I	21	85
600	16	2	0	−14	45	I	25	103
601	16	2	0	−15	15	I	33	137
602	16	2	0	−15	45	I	25	104
603	16	2	0	−16	15	I	23	102
604	16	2	0	−16	45	I	35	146
605	16	3	0	− 6	30	I	26	105
606	16	4	0	− 6	0	I	19	77
607	16	4	0	− 7	0	I	24	97
608	16	4	0	−14	45	I	29	119
609	16	4	0	−15	15	I	28	116
610	16	4	0	−15	45	I	26	108
611	16	5	0	− 6	30	I	19	77
612	16	6	0	− 7	0	I	25	101
613	16	8	0	− 7	0	I	20	81
614	16	10	0	− 7	0	I	18	73

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
615	16 12 0	— 6 45	I	21	85
616	16 14 0	— 6 45	I	20	80
617	16 16 0	— 6 45	I	20	80
618	16 17 0	—16 0	I	27	112
619	16 18 0	— 6 30	I	26	105
620	16 19 0	—16 0	I	13	54
621	17 42 0	— 6 15	II	71	286
622	17 42 0	— 6 45	II	70	282
623	17 44 0	— 6 15	II	73	294
624	17 44 0	-- 6 45	II	59	237
625	17 46 0	— 6 15	II	54	217
626	17 46 0	— 6 45	II	55	221
627	17 48 0	— 6 45	II	54	217
628	17 52 0	— 6 15	II	70	282
629	17 52 0	— 6 45	II	63	254
630	17 54 0	— 6 15	II	43	173
631	17 54 0	— 6 45	II	44	177
632	17 56 0	— 6 45	II	47	189
633	17 58 0	— 6 45	II	44	177
634	18 0 0	— 6 45	II	39	157
635	18 7 0	—32 15	I	36	170
636	18 9 0	—31 45	I	43	203
637	18 9 0	—32 15	I	35	165
638	18 11 0	—31 45	I	40	189
639	18 11 0	—32 15	I	57	268
640	19 3 0	—23 0	I	32	140
641	19 5 0	—23 0	I	50	218
642	19 7 0	—22 45	I	51	220

TABLE III.—COUNTS OF STARS—Continued.

No.	R. A. 1860.			Dec. 1860.		Telescope.	No. Stars.	4 Sec. δ × No.
	h.	m.	s.	°	′			
643	19	9	0	—22	45	I	60	259
644	19	16	0	—22	15	I	73	315
645	19	18	0	—22	15	I	42	181
646	19	21	0	—25	0	II	61	263
647	20	32	0	+ 1	0	I	64	256
648	20	34	0	+ 1	0	I	51	204
649	20	36	0	+ 1	15	I	40	160
650	20	38	0	+ 1	15	I	58	232
651	20	40	0	+ 1	15	I	37	148
652	20	42	0	+ 1	15	I	32	128
653	20	44	0	+ 1	15	I	50	200
654	20	46	0	+ 1	15	I	36	144
655	21	42	0	—12	15	I	24	98
656	21	42	0	—13	15	II	28	115
657	21	42	0	—13	45	II	30	124
658	21	43	0	—11	45	I	23	94
659	21	45	0	—11	45	I	25	102
660	21	47	0	—11	30	I	21	86
661	21	49	0	—11	15	I	27	110
662	21	51	0	—10	30	I	25	102
663	21	51	0	—11	0	I	19	77
664	21	53	0	—10	30	I	15	61
665	22	2	0	+ 1	0	I	14	56
666	22	4	0	+ 1	0	I	10	40
667	22	6	0	+ 1	0	I	8	32
668	22	8	0	+ 1	0	I	11	44
669	22	10	0	+ 1	0	I	12	48
670	22	12	0	+ 1	0	I	10	40

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
671	22 14 0	+ 1 0	I	13	52
672	22 16 0	+ 1 0	I	18	72
673	22 18 0	+ 1 0	I	24	96
674	22 20 0	+ 1 0	I	10	40
675	22 22 0	+ 2 0	I	18	72
676	22 22 0	+ 1 30	I	28	112
677	22 22 0	+ 1 0	I	29	116
678	22 22 0	— 1 45	I	24	96
679	22 22 0	— 2 15	I	24	96
680	22 24 0	+ 2 0	I	12	48
681	22 24 0	+ 1 30	I	31	124
682	22 24 0	+ 1 0	I	32	128
683	22 24 0	— 1 45	I	25	100
684	22 24 0	— 2 15	I	18	72
685	22 26 0	+ 2 0	I	13	52
686	22 26 0	+ 1 30	I	17	68
687	22 26 0	— 1 45	I	25	100
688	22 26 0	— 2 15	I	29	116
689	22 28 0	+ 2 0	I	28	112
690	22 28 0	+ 1 30	I	26	104
691	22 28 0	— 1 45	I	23	92
692	22 30 0	+ 2 0	I	25	100
693	22 30 0	+ 1 30	I	24	96
694	22 30 0	— 1 15	I	21	84
695	22 30 0	— 1 45	I	32	128
696	22 32 0	+ 2 0	I	24	96
697	22 32 0	+ 1 30	I	24	96
698	22 32 0	— 1 15	I	38	152

TABLE III—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
699	22 32 0	— 1 45	I	28	112
700	22 34 0	+ 2 0	I	29	116
701	22 34 0	+ 1 30	I	18	72
702	22 34 0	— 1 15	I	22	88
703	22 35 0	— 0 45	I	22	88
704	22 36 0	+ 2 0	I	16	64
705	22 36 0	— 1 15	I	22	88
706	22 37 0	— 0 45	I	10?	40?
707	22 38 0	+ 2 0	I	25	100
708	22 38 0	— 1 15	I	21	84
709	22 39 0	— 0 45	I	22	88
710	22 41 0	— 9 30	I	37	149
711	22 42 0	— 0 30	I	14	56
712	22 42 0	—12 15	I	15	60
713	22 43 0	— 9 30	I	19	77
714	21 44 0	— 0 15	I	18	72
715	22 44 0	—12 0	I	22	90
716	22 45 0	— 9 0	I	26	105
717	22 46 0	— 0 15	I	26	104
718	22 46 0	—11 45	I	13	53
719	22 47 0	— 8 45	I	26	105
720	22 48 0	— 0 0	I	27	108
721	22 48 0	— 8 0	I	21	85
722	22 48 0	—11 30	I	15	61
723	22 49 0	— 7 30	I	24	97
724	22 49 0	— 8 30	I	27	109
725	22 49 0	—11 0	I	13	52
726	22 50 0	— 0 0	I	16	64

TABLE III — COUNTS OF STARS — Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
727	22 50 0	—11 30	I	14	57
728	22 51 0	—11 0	I	17	69
729	22 52 0	— 0 0	I	12	48
730	22 52 0	— 1 0	I	21	84
731	22 54 0	+ 0 15	I	24	96
732	22 54 0	— 0 15	I	14	56
733	22 56 0	+ 0 30	I	21	84
734	22 56 0	+ 0 0	I	20	80
735	22 56 0	— 0 30	I	23	92
736	22 58 0	+ 0 30	I	24	96
737	22 58 0	+ 0 0	I	21	84
738	22 58 0	— 0 30	I	20	80
739	23 0 0	+ 0 0	I	13	52
740	23 0 0	— 0 30	I	15	60
741	23 1 0	+ 1 15	I	17	68
742	23 1 0	+ 0 45	I	23	92
743	23 2 0	—10 15	I	17	68
744	23 3 0	+ 1 15	I	18	72
745	23 3 0	+ 0 45	I	29	116
746	23 4 0	—10 0	I	19	77
747	23 5 0	+ 1 15	I	27	108
748	23 6 0	+ 9 45	I	19	77
749	23 7 0	+ 1 45	I	21	84
750	23 7 0	+ 1 15	I	23	92
751	23 8 0	— 9 30	I	19	77
752	23 9 0	+ 1 45	I	20	80
753	23 9 0	+ 1 15	I	26	104
754	23 10 0	— 9 15	I	22	89

TABLE III.—COUNTS OF STARS—Continued.

No.	R. A. 1860.	Dec. 1860.	Telescope.	No. Stars.	4 Sec. δ × No.
	h. m. s.	° ′			
755	23 11 0	+ 1 45	I	15	60
756	23 11 0	+ 1 15	I	22	88
757	23 12 0	— 9 15	I	18	73
758	23 13 0	+ 1 45	I	16	64
759	23 13 0	+ 1 15	I	23	92
760	23 14 0	— 9 0	I	21	85
761	23 15 0	+ 1 45	I	22	88
762	23 17 0	+ 1 45	I	21	84
763	23 18 0	+ 2 15	I	22	88
764	23 19 0	+ 2 45	I	24	92
765	23 19 0	+ 1 45	I	26	104
766	23 20 0	+ 2 15	I	31	124
767	23 29 0	— 8 30	I	20	81
768	23 31 0	— 8 15	I	32	129
769	23 33 0	— 8 15	I	37	149
770	23 35 0	— 8 15	I	29	117
771	23 45 0	— 6 45	I	12	48
772	23 45 0	— 7 15	I	18	73
773	23 47 0	— 6 30	I	11	44
774	23 47 0	— 7 0	I	16	64
775	23 49 0	— 6 15	I	17	68
776	23 51 0	— 5 45	I	15	60
777	23 52 0	— 5 15	I	16	64
778	23 53 0	— 5 45	I	10	40
779	23 55 0	— 5 45	I	13	52
780	23 57 0	— 5 45	I	18	72
781	23 59 0	— 5 45	I	11	44

COUNTS OF STARS FROM PALISA'S PUBLISHED CHARTS, Nos. 2 AND 3, MADE WITH THE 12 INCH REFRACTOR OF VIENNA.

No.	R. A. 1860.		Dec. 1860.		No. Stars per 1°	(No. Stars) Sec. δ
	h.	m.	°	′		
782	10	2	+13	30	97	100
783		2	+12	30	99	101
784		2	+11	30	88	90
785		2	+10	30	97	99
786		2	+ 9	30	99	100
787	10	6	+13	30	101	104
788		6	+12	30	106	108
789		6	+11	30	128	131
790		6	+10	30	118	120
791		6	+ 9	30	102	103
792	10	10	+13	30	114	117
793		10	+12	30	104	106
794		10	+11	30	100	102
795		10	+10	30	91	93
796		10	+ 9	30	100	101
797	10	14	+13	30	81	83
798		14	+12	30	111	113
799		14	+11	30	100	102
800		14	+10	30	79	81
801		14	+ 9	30	109	110
802	10	18	+13	30	107	110
803		18	+12	30	97	99
804		18	+11	30	120	122
805		18	+10	30	99	101
806	10	18	+ 9	30	114	115

COUNTS OF STARS FROM PALISA'S PUBLISHED CHARTS, NOS. 2 AND 3—Continued.

No.	R. A. 1860,	Dec. 1860.	No. Stars per 1°	(No. Stars) Sec. δ
	h. m.	° ′		
807	12 22	+ 4 15	112	112
808	22	+ 3 15	132	132
807	22	+ 2 15	137	137
810	22	+ 1 15	124	124
811	22	+ 0 15	122	122
812	12 26	+ 4 15	122	122
813	26	+ 3 15	117	117
814	26	+ 2 15	114	114
815	26	+ 1 15	117	117
816	26	+ 0 15	136	136
817	12 30	+ 4 15	122	122
818	30	+ 3 15	127	127
819	30	+ 2 15	123	123
820	30	+ 1 15	138	138
821	30	+ 0 15	105	105
822	12 34	+ 4 15	109	109
823	34	+ 3 15	121	121
824	34	+ 2 15	138	138
825	34	+ 1 15	119	119
826	34	+ 0 15	141	141
827	12 38	+ 4 15	129	129
828	38	+ 3 15	121	121
829	38	+ 2 15	113	113
830	38	+ 1 15	120	120
831	38	+ 0 15	113	113

COUNTS OF STARS FROM PALISA'S PUBLISHED CHART IN 22 HOURS MADE WITH THE 6-INCH REFRACTOR AT POLA.

No.	R. A. 1860.	Dec. 1860.	No. Stars per 1°.	No. Stars Sec. δ.
	h. m.	° ′		
832	22 2	—13 30	133	137
833	2	—12 30	129	132
834	2	—11 30	139	142
835	2	—10 30	157	160
836	2	— 9 30	133	134
837	22 6	—13 30	154	159
838	6	—12 30	117	119
839	6	—11 30	135	138
840	6	—10 30	134	137
841	6	— 9 30	142	143
842	22 10	—13 30	150	155
843	10	—12 30	121	123
844	10	—11 30	134	137
845	10	—10 30	120	122
846	10	— 9 30	130	131
847	22 14	—13 30	128	132
848	14	—12 30	120	122
849	14	—11 30	116	118
850	14	—10 30	101	103
851	14	— 9 30	142	143
852	22 18	—13 30	117	121
853	18	—12 30	110	112
854	18	—11 30	123	125
855	18	—10 30	124	126
856	18	— 9 30	124	125

The data of the preceding tables may be combined in various ways. I conceive that the presentation of the immediate and crude results of observation will not be unwelcome to astronomers. Tables A and B, immediately following, summarize them as follows: In Table A the first column gives the authority; the second, the number of gauges, or counts; the third, the number of separate pointings of the telescope; the fourth, the total number of stars counted (for PALISA and PETERS, the *actual* number of stars counted in each 4^m of R. A. by 1° in Dec., has been multiplied by Sec. δ before making the summation.); the fifth, the average number of stars per count, or gauge; the sixth, the average number of stars per square degree of a great circle; the seventh, the limits of magnitude (approximate) of the stars counted; the eighth, the number of stars down to each certain magnitude, which would be scattered over the whole surface of the sky, *provided,* the distribution over the whole sky was the same as that in the special area counted; the ninth, the *limits* of declination of the special areas considered (the limits of R. A. being 0^h and 24^h in each case, though the whole 24^h in R. A. is only investigated in the first 8 horizontal lines); and the tenth, the actual number of square degrees which have been counted, and upon which the numbers in the eighth column depend.

The table furnishes several simple proofs that the stars cannot be regarded as equably distributed in space. The gauges of the elder HERSCHEL, numbers 13 and 14, for example, may be taken as two fairly comparable determinations of the same quantity. Any satisfactory formula should cover these two cases, as indeed it should cover the gauges of SIR JOHN HERSCHEL. The first two determinations (Series I and II) differ from each other by over 30 *per cent.* of the smaller, and hence no expression of the form $\Sigma_m = a\ b^m$ will serve to represent the numbers of col. 8 throughout, though such a one may serve as far as the 11 mag. The limiting magnitudes in col. 7 will be fixed by the photometric determinations of the Harvard College Observatory, except perhaps those corresponding to the HERSCHEL gauges.

TABLE A — STATISTICS OF STAR-GAUGES.

Authority.	Number of counts or gauges.	Number of fields.	Total number of stars counted.	Average number of stars per count or gauge.	Average number of stars per 1° square.	Limits of magnitude.	Proportional number of stars in the whole sky.	Limits of declination of the counts.	Number of square degrees actually counted.
								° °	
No.									
1. ARGELANDER; Uran. Nova.	.....	.....	2,352	.....	0.11	1— 6?	4,704	+90 ; 0	20,626.5
2. BEHRMANN; Atlas.....	.....	.....	2,328	.....	0.17	1— 6?	6,964	—20 ;—90	13,790.
3. HOUZEAU; Uran. Gen.....	.....	.....	5,719	.....	0.14	1— 6?	5,719	+90 ;—90	41,253.
4. HEIS; Atlas Coel.....	.....	.....	3,903	.....	0.19	1— 6.5?	7,806	+90 ; 0	20,626.5
5. GOULD; Uran. Arg.....	.....	.....	6,694	.....	0.32	1— 7.0?	13,388	0 ;—90	20,626.5
6. ARGELANDER; DM.....	.....	.....	25,321	.....	1.23	1— 8.0?	50,642	+90 ;— 0	20,626.5
7. ARGELANDER; DM.....	.....	.....	324,198	.....	15.19	1—10. ?	626,630	+90 ;— 2	21,344.7
8. CELORIA; Pub. Milan XIII.	.....	27,216	200,781	.....	93.12	1—11. ?	3,841,650	+ 6 ; 0	2,156.5
9. PALISA; Ms. and pub.(Pola.)	628	.....	62,774	.....	99.96	1—13. ?	4,123,600	+28 ;—32	175 ±
10. PALISA; Ms. and published (Vienna).....	228	.....	29,574	.....	129.71	1—14.6?	5,350,900	+29 ;—25	94 ±
11. PETERS; Ms. maps (only)..	954	.....	68,410	.....	71.71	1—14.8?	2,958,200	+25 ;—26	950 ±
12. PETERS; published maps..	500	.....	43,928	.....	87.87	1—14.9?	3,624,800	+20 ;—25	500 ±
13. W. HERSCHEL; Series I. (published).....	683	3,400	27,989	40.98	827.46	1—15. ?	34,135,000	+46 ;—32	168.3
14. W. HERSCHEL; Series II. (unpublished).....	405	2,245	21,964	54.23	1095.1	1—15. ?	45,174,000	+81 ;—32	111.2
15. J. HERSCHEL; C. G. H.....	605	2,299	68,948	113.96	2301.2	1—15. ?	94,929,000	0 ;—90	113.9
16. W. and J. HERSCHEL; all observed.....	1,693	7,944	118,882	70.22	1417.9	1—15. ?	58,492,000	+81 ;—90	393.4

In table A it is clear that the irregularity of the distribution of the stars in R. A. in the various series has influenced the Nos. of col. 8 so that they are not comparable. The numbers for PALISA'S 6 inch telescope are greater than those for PETERS. The table B gives similar data for certain of the authorities for every 20^m of R. A. throughout the 24^h. All the counts refer to 1860.0, except those of ARGELANDER, which are given for 1855.0.

Column 1 gives the limits of R. A.; column 2 gives the average number of stars from the first to the tenth magnitude, in the *Durchmusterung*, quoted from the Bonn observations, vol. 5; column 3 gives the number of counts of areas of 2^m in R. A. by 30′, made by DR. PALISA on his Pola maps, and column 5 the same datum for his Vienna maps (these include both published and unpublished maps); column 4 gives the number of stars per 1° square derived from the Pola maps, and column 6 the same quantity for the Vienna maps; these numbers are the sum of the quantities 4 sec. δ times the *actual* number of stars, divided by the number of counts; column 7 gives the number of square degrees counted on DR. PETERS' ms. maps (not including a very few of Professor WATSON'S), and column 8 gives the average number of stars per 1° square for PETERS', derived as above; column 9 gives the number of gauges (not fields) counted by SIR W. HERSCHEL within the R. A.'s noted, and column 10 gives the number of stars per 1° square for HERSCHEL.

The limits of declination are given in Table A. I have not included Sir J. HERSCHEL'S gauges, as they refer to the southern hemisphere only, while the others refer partly to the northern sky.

The last four columns of the table give the ratios:—

No. of stars per 1° (HERSCHEL) divided by No. of stars per 1° for ARGELANDER, PALISA (Pola), PALISA (Vienna) and PETERS, respectively.

These ratios show again how far from uniform is the scattering of the stars. While it is true that the problem of the true distribution of the stars, if it is to be solved at all, must be solved by neglecting the individual peculiarities of small regions, yet it appears to be evident from the table, that areas much smaller than 20 *m.* in R. A. by 92° in declination must be considered. I have taken them so large in this table only because the counts for the *Durchmusterung* are given to every 20 *m.*

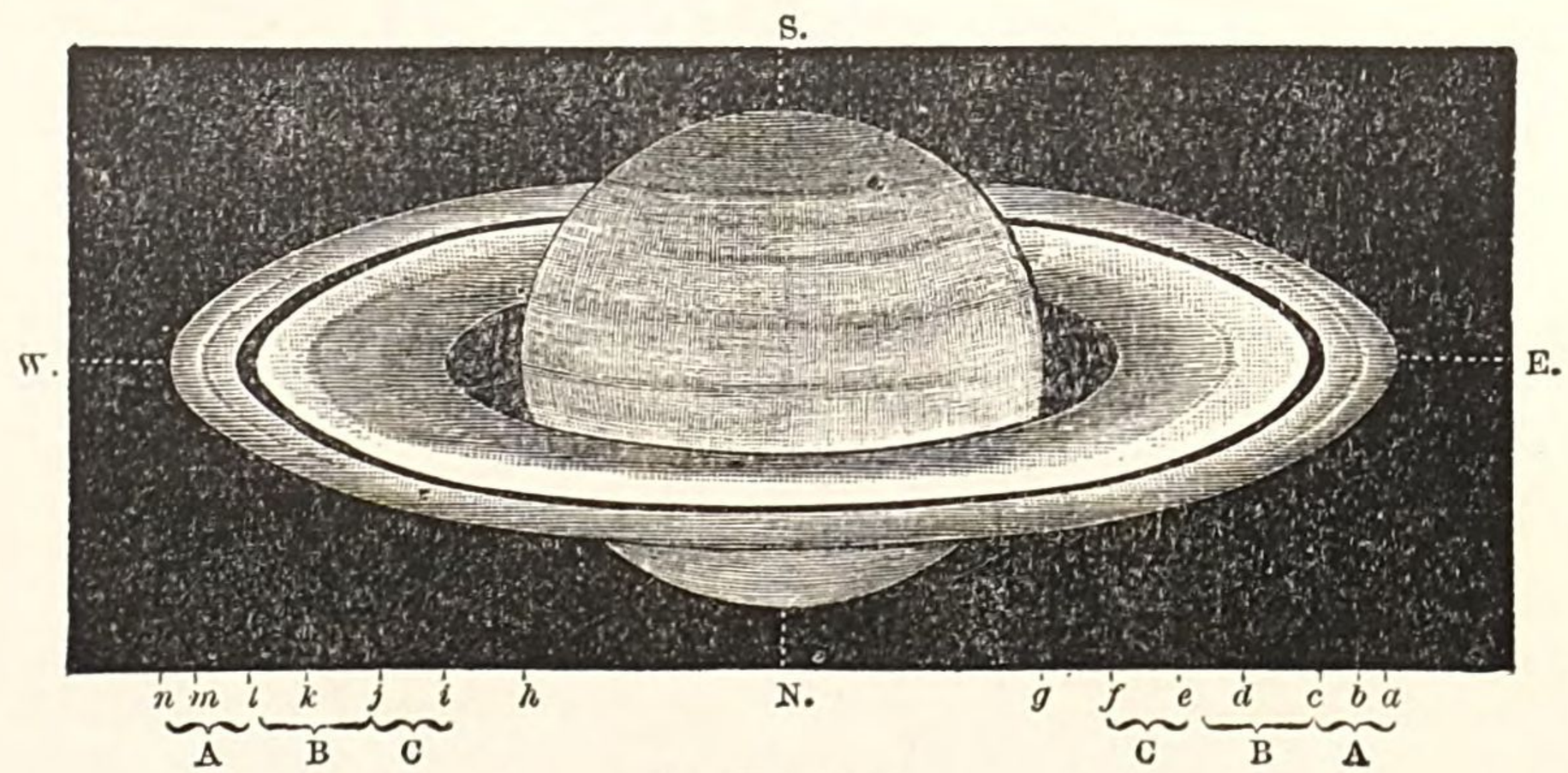
TABLE B—STATISTICS OF STAR GAUGES.

Limiting R. A. 1860.0					ARGELANDER, D. M. No. of Stars per 1° 1-10 mags.	PALISA'S Pola Maps.		PALISA'S Vienna Maps.		PETERS' Ms. Maps.		W. HERSCHEL'S Gauges.		HERSCHEL ÷ ARGELANDER.	HERSCHEL ÷ PALISA (Pola).	HERSHEL ÷ PALISA (Vienna).	HERSCHEL ÷ PETERS (ms.)
						No. of ¼ degrees counted.	No. of Stars per 1°. 1—13? mags.	No. of ¼ Degrees counted.	No. of Stars per 1°. 1—14.6? mags.	No. of degrees counted.	No. of Stars per 1°. 1—14.8 mags.	No. of Gauges.	No. of Stars per 1°. 1—15? mags.				
h.	m.		h.	m.													
0	0	to	0	20	15.9	29	76.	13	104.8	45	53.7	12	240	15.1	3.2	2.3	4.5
0	20	to	0	40	15.9	1	61.	.....	.....	.....	.....	8	481	30.3	7.9	.....	.....
0	40	to	1	0	15.7	.....	.....	.....	.....	40	62.1	12	459	29.2	.....	.....	7.4
1	0	to	2	20	15.3	.....	.....	.....	.....	50	71.0	21	313	20.5	.....	.....	4.4
1	20	to	1	40	15.9	.....	.....	10	93.	15	60.3	9	436	27.4	.....	4.7	7.2
1	40	to	2	0	15.5	9	80.9	36	87.9	12	72.5	9	166	10.7	2.1	1.9	2.3
2	0	to	2	20	15.2	15	67.9	3	90.	.....	.....	9	160	10.5	2.4	1.8	.....
2	20	to	2	40	14.7	53	84.2	.....	.....	.....	.....	16	487	33.1	5.8	.....	.....
2	40	to	3	0	13.3	24	80.0	.....	.....	.....	.....	10	198	14.9	2.5	.....	.....
3	0	to	3	20	13.5	8	56.5	19	136.3	25	86.8	8	129	9.6	2.3	0.9	1.5
3	20	to	3	40	13.4	17	86.8	5	128.	.....	.....	12	267	19.9	3.1	2.1	.....
3	40	to	4	0	13.1	14	112.6	.....	.....	.....	.....	11	285	21.8	2.5	.....	.....
4	0	to	4	20	12.7	9	102.	.....	.....	25	70.5	11	164	12.9	1.6	.....	2.3
4	20	to	4	40	12.9	16	108.5	.....	.....	.....	.....	15	287	22.2	2.6	.....	.....
4	40	to	5	0	16.3	8	108.1	.....	.....	25	123.0	10	372	22.8	3.4	.....	3.0
5	0	to	5	20	18.7	1	157.	.....	.....	.....	.....	11	709	37.9	4.5	.....	.....
5	20	to	5	40	21.1	.....	.....	.....	.....	.....	.....	14	739	35.0	.....	.....	.....
5	40	to	6	0	21.6	6	204.8	.....	.....	.....	.....	28	1,182	54.7	5.8	.....	.....
6	0	to	6	20	22.6	.....	.....	.....	.....	.....	.....	34	1,420	62.8	.....	.....	.....
6	20	to	6	40	22.8	4	294.5	.....	.....	.....	.....	28	1,295	56.8	4.4	.....	.....
6	40	to	7	0	22.0	8	341.4	.....	.....	.....	.....	36	1,683	76.5	4.9	.....	.....
7	0	to	7	20	18.9	.....	.....	.....	.....	.....	.....	25	1,810	95.8	.....	.....	.....

7	20	to	7	40	16.8	6	185.	.....	.....	.....	.....	25	1,974	117.5	10.7	.....	.....
7	40	to	8	0	15.6	17	183.4	10	187.	2	130.5	17	1,921	123.1	10.5	10.3	14.7
8	0	to	8	20	14.4	8	182.	25	224.5	.....	.....	12	1,380	95.9	7.6	6.1	.....
8	20	to	8	40	13.2	.....	.....	.....	.....	16	80.8	6	652	49.4	.....	.....	8.1
8	40	to	9	0	12.2	2	107.	.....	.....	16	67.5	15	382	31.3	3.6	.....	5.7
9	0	to	9	20	11.2	16	70.8	.....	.....	20	62.7	6	444	39.6	6.3	.....	7.1
9	20	to	9	40	10.4	57	80.1	19	80.2	16	62.0	7	291	27.9	3.6	3.6	4.7
9	40	to	10	0	10.1	9	107.7	3	98.7	21	66.3	11	236	23.4	2.2	2.4	3.6
10	0	to	10	20	9.7	25	91.	25	104.4	25	76.7	4	222	22.9	2.4	2.1	2.9
10	20	to	10	40	9.0	7	82.3	.....	.....	15	55.3	9	143	15.9	1.7	.....	2.6
10	40	to	11	0	9.2	1	44.	.....	.....	15	72.2	4	232	25.2	5.3	.....	3.2
11	0	to	11	20	8.5	20	77.9	6	97.8	45	54.8	6	156	18.4	2.0	1.6	2.8
11	20	to	11	40	8.8	9	72.	.....	.....	36	58.3	7	133	15.1	1.9	.....	2.3
11	40	to	12	0	8.3	.....	.....	.....	.....	44	57.5	3	135	16.4	.....	.....	2.3
12	0	to	12	20	8.4	.....	.....	3	121.3	75	59.8	4	121	14.4	.....	1.0	2.0
12	20	to	12	40	8.8	.....	.....	31	123.5	5	58.6	6	145	16.5	.....	1.2	2.5
12	40	to	13	0	8.7	.....	.....	3	86.3	4	59.5	5	133	15.3	.....	1.5	2.2
13	0	to	13	20	8.5	9	92.2	.....	.....	.....	.....	8	133	15.7	1.4	.....	.....
13	20	to	13	40	8.9	19	68.4	.....	.....	5	70.	10	152	17.1	2.2	.....	2.2
13	40	to	14	0	8.9	3	64.7	.....	.....	25	74.8	9	168	18.9	2.6	.....	2.2
14	0	to	14	20	9.4	.....	.....	.....	.....	25	83.6	11	202	21.5	.....	.....	2.4
14	20	to	14	40	9.4	.....	.....	.....	.....	.....	.....	8	192	20.4	.....	.....	.....
14	40	to	15	0	9.6	.....	.....	.....	.....	.....	.....	12	202	21.1	.....	.....	.....
15	0	to	15	20	9.6	.....	.....	.....	.....	.....	.....	10	166	17.3	.....	.....	.....
15	20	to	15	40	10.0	.....	.....	.....	.....	5	96.8	19	206	20.6	.....	.....	2.1
15	40	to	16	0	10.7	5	65.	.....	.....	5	102.2	17	295	27.6	4.5	.....	2.9
16	0	to	16	20	11.7	24	90.4	.....	.....	.....	.....	19	180	15.4	2.0	.....	.....
16	20	to	16	40	12.0	.....	.....	.....	.....	.....	.....	17	331	27.5	.....	.....	.....
16	40	to	17	0	12.9	.....	.....	.....	.....	.....	.....	11	432	33.5	.....	.....	.....
17	0	to	17	20	13.3	.....	.....	.....	.....	.....	.....	8	537	40.4	.....	.....	.....
17	20	to	17	40	16.0	.....	.....	.....	.....	.....	.....	9	497	31.0	.....	.....	.....
17	40	to	18	0	17.4	.....	.....	13	231.2	.....	.....	12	1,081	62.1	.....	4.7	.....
18	0	to	18	20	20.3	5	199.	1	157.	.....	.....	20	1,563	77.0	7.9	10.0	.....
18	20	to	18	40	21.6	.....	.....	.....	.....	.....	.....	36	1,018	47.1	.....	.....	.....
18	40	to	19	0	22.9	.....	.....	.....	.....	.....	.....	31	2,266	97.2	.....	.....	.....
19	0	to	29	20	23.5	6	222.2	.....	.....	10	200.3	23	2,772	113.7	12.0	.....	13.4

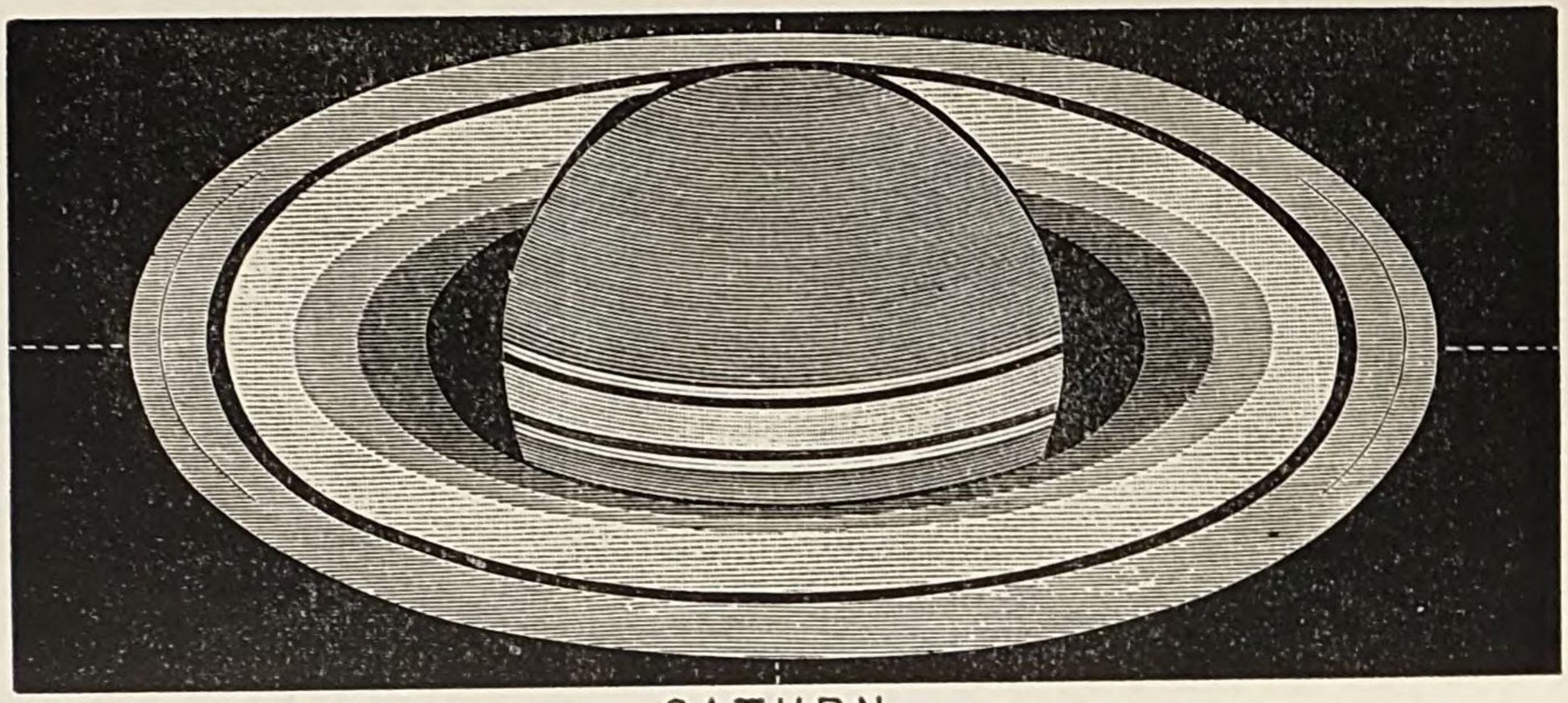
TABLE B—STATISTICS OF STAR GUAGES—Continued.

Limiting R. A. 1860.0.					ARGELANDER, D. M. No. of Stars per 1°.1—10 Mags.	PALISA'S Pola Maps.		PALISA'S Vienna Maps.		PETERS' Ms. Maps.		W. HERSCHEL'S Gauges.		HERSCHEL ÷ ARGELANDER.	HERSCHEL ÷ PALISA (Pola.)	HERSCHEL ÷ PALISA (Vienna.)	HERSCHEL ÷ PETERS', (Ms.)
						No. of ¼ Degrees counted.	No. of Stars per 1°. 1—13? Mags.	No. of ¼ Degrees counted.	No. of Stars per 1°. 1—14.6? Mags.	No. of Degrees counted.	No. of Stars per 1°. 1—14.8? Mags.	Number of Gauges.	No. of Stars per 1°. 1—15? Mags.				
h.	m.		h.	m.													
19	20	to	19	40	26.6	.....	.....	1	263.	.....	.....	42	4,547	170.9	.....	17.3	.....
19	40	to	20	0	27.5	.....	.....	.....	.....	.....	.....	37	4,153	151.0	.....	.....	.....
20	0	to	20	20	25.8	.....	.....	.....	.....	5	132.4	33	2,165	83.9	.....	.....	16.4
20	20	to	20	40	23.7	4	213.	.....	.....	5	97.0	25	1,370	57.8	6.4	.....	14.1
20	40	to	21	0	22.0	4	155.	.....	.....	5	78.2	27	1,927	87.6	12.4	.....	24.7
21	0	to	21	20	20.6	.....	.....	.....	.....	25	81.4	23	1,505	73.0	.....	.....	18.5
21	20	to	21	40	19.8	.....	.....	.....	.....	49	91.0	15	964	48.7	.....	.....	10.6
21	40	to	22	0	18.7	8	92.5	2	119.5	31	86.7	15	1,376	73.6	14.9	11.5	15.9
22	0	to	22	20	18.7	34	111.1	.....	.....	50	76.8	16	503	26.9	4.5	.....	6.6
22	20	to	22	40	18.2	36	29.8	.....	.....	25	65.0	12	176	9.7	1.9	.....	2.7
22	40	to	23	0	17.4	29	81.8	.....	.....	25	59.8	13	297	17.1	3.6	.....	5.0
23	0	to	23	20	16.1	27	82.4	.....	.....	17	66.1	17	214	13.3	2.6	.....	3.2
23	20	to	23	40	16.1	5	120.	.....	.....	30	53.7	11	131	8.1	1.1	.....	2.4
23	40	to	24	0	15.5	11	57.2	.....	.....	20	62.1	10	234	15.1	4.1	.....	3.8
Sums						628	5113.1	228	2534.4	954	3280.3	1088	53,797				
Weighted means					15.19 (72)		116.2 (44)		133.4 (19)		80.1 (41)		747.2 (72)				



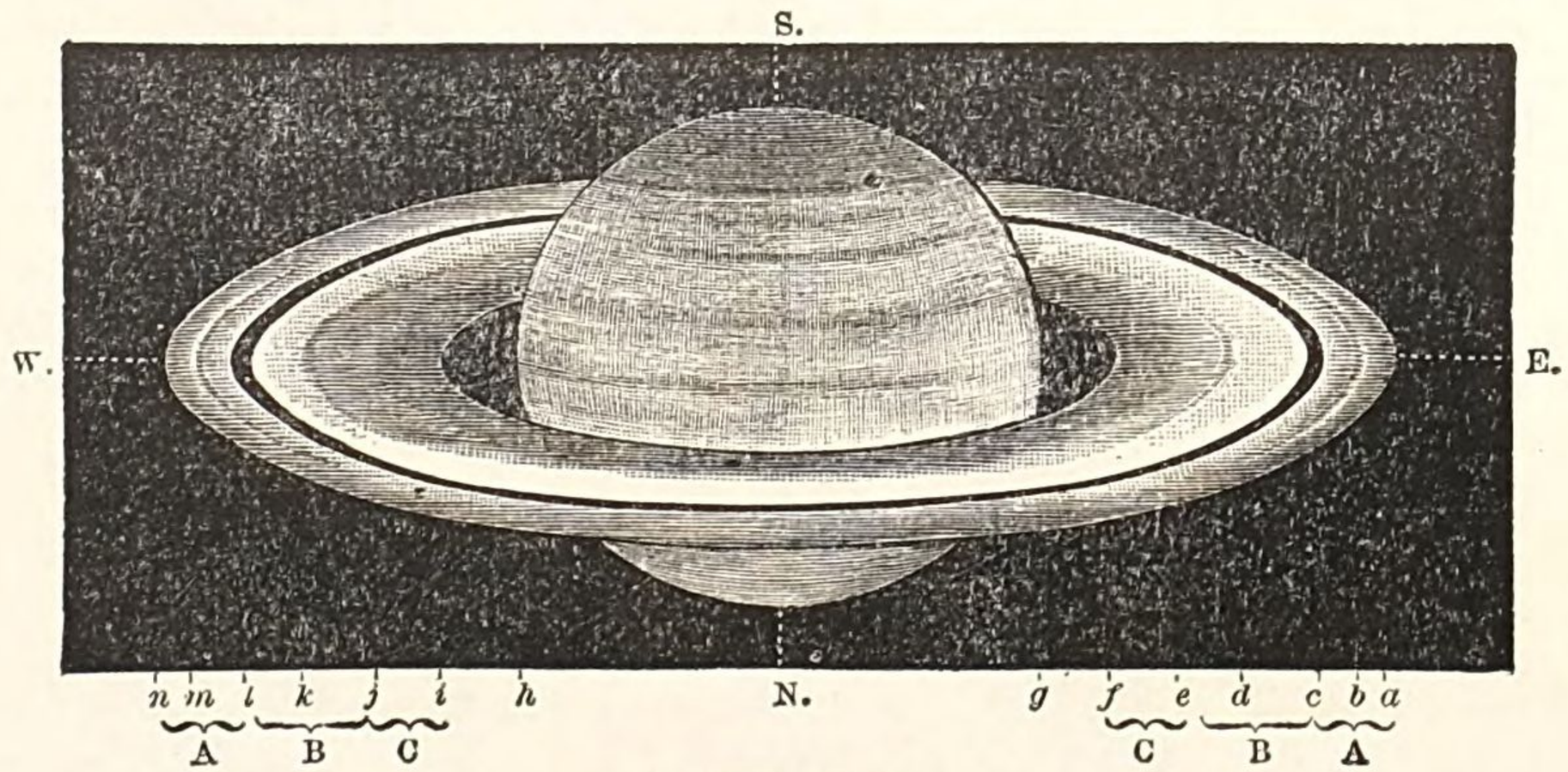
SATURN.

(1881, November 27.)



SATURN.

(1883, DECEMBER 2.)



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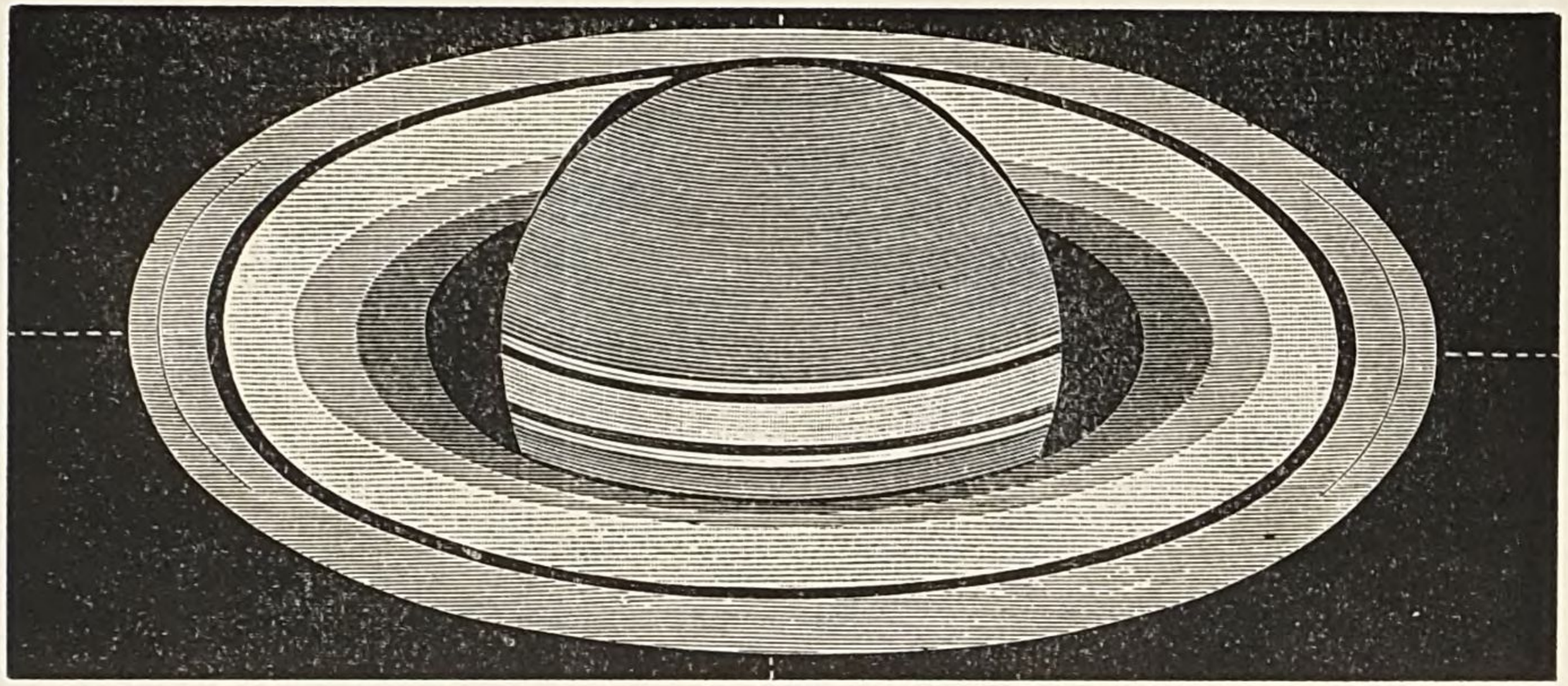
(1881, November 27.)



SATURN.

(1883, DECEMBER 2.)

XIII. TABLE OF PRECESSIONS IN RIGHT ASCENSION AND DECLINATION FOR 1880.0.

These tables were prepared at the Washburn Observatory by Mr. GEORGE C. COMSTOCK, and they are printed in the hope that they may be found generally useful.

Within the limits of declination $\pm 20°$ the precessions in R. A. were copied from the table given in *Publicationen des Astrophysikalischen Observatoriums zu Potsdam, Dritter Band*, pp. 222–225. The remainder of the precessions were computed from the formulæ,

$$\triangle \alpha = m + n \sin \alpha \operatorname{tg} \delta. \qquad \triangle \delta = n \cos \alpha$$

using the STRUVE-PETERS constants. For 1880.0

$$m = 3^{s}.0723. \qquad \log n = 1.30220.$$

The variation in 100 years of the precession in R. A. for a given α and δ may be found approximately by dividing the precession in R. A. for α and $-\delta$ by 1750.

The corresponding variation of the precession in declination is $-\frac{1}{2300}$ (the precession in declination).

TABLE OF PRECESSIONS IN DECLINATION FOR 1880.0

R. A.				Precession	R. A.			
h.	m.	h.	m.	″	h.	m.	h.	m.
0	0	24	0	+20.05—	12	0	12	0
	10	23	50	20.04		10	11	50
	20		40	19.98		20		40
	30		30	19.88		30		30
	40		40	19.75		40		20
	50		10	19.58		50		10
1	0	23	0	+19.37—	13	0	11	0
	10	22	50	19.13		10	10	50
	20		40	18.84		20		40
	30		30	18.53		30		30
	40		20	18.18		40		20
	50		10	17.79		50		10
2	0	22	0	+17.37—	14	0	10	0
	10	21	50	16.91		10	9	50
	20		40	16.43		20		40
	30		30	15.91		30		30
	40		20	15.36		40		20
	50		10	14.79		50		10
3	0	21	0	+14.18—	15	0	9	0
	10	20	50	13.55		10	8	50
	20		40	12.89		20		40
	30		30	12.21		30		30
	40		20	11.50		40		20
	50		10	10.77		50		10
4	0	20	0	+10.03—	16	0	8	0
	10	19	50	9.26		10	7	50
	20		40	8 48		20		40
	30		30	7.67		30		30
	40		20	6.86		40		20
	50		10	6.03		50		10
5	0	19	0	+ 5.19—	17	0	7	0
	10	18	50	4.34		10	6	50
	20		40	3.48		20		40
	30		30	2.62		30		30
	40		20	1.75		40		20
	50		10	0.87		50		10
6	0	18	0	+ 0.00—	18	0	6	0

0.° TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

R. A. for + δ				0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	R. A. for — δ	
h.	m.	h.	m.	s	s	s	s	s	s	s	s	s	s	s	h. m.	h. m.
0	0	12	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	12 0	24 0
	10	11	50	.072	.073	.074	.075	.076	.077	.078	.080	.081	.082	.083	10	23 50
	20		40	.072	.074	.076	.078	.080	.082	.084	.087	.089	.091	.093	20	40
	30		30	.072	.075	.078	.081	.084	.087	.090	.094	.097	.100	.103	30	30
	40		20	.072	.076	.080	.084	.088	.092	.096	.101	.105	.109	.113	40	20
	50		10	.072	.077	.082	.087	.092	.097	.102	.108	.113	.118	.123	50	10
1	0	11	0	3.072	3.078	3.084	3.090	3.096	3.102	3.108	3.115	3.121	3.127	3.133	13 0	23 0
	10	10	50	.072	.079	.086	.093	.100	.107	.114	.122	.129	.136	.143	10	22 50
	20		40	.072	.080	.088	.096	.104	.112	.120	.128	.136	.144	.152	20	40
	30		30	.072	.081	.090	.099	.108	.117	.126	.135	.144	.153	.162	30	30
	40		20	.072	.082	.092	.102	.111	.121	.131	.141	.151	.161	.171	40	20
	50		10	.072	.083	.094	.105	.115	.126	.137	.148	.159	.170	.181	50	10
2	0	10	0	3.072	3.084	3.095	3.107	3.118	3.130	3.142	3.154	3.166	3.178	3.190	14 0	22 0
	10	9	50	.072	.085	.097	.110	.122	.135	.147	.160	.173	.186	.199	10	21 50
	20		40	.072	.086	.099	.112	.125	.139	.152	.166	.180	.193	.207	20	40
	30		30	.072	.087	.101	.115	.129	.143	.157	.172	.187	.201	.215	30	30
	40		20	.072	.087	.102	.117	.132	.147	.162	.178	.193	.208	.223	40	20
	50		10	.072	.088	.104	.120	.135	.151	.167	.183	.199	.215	.231	50	10
3	0	9	0	3.072	3 089	3.105	3.122	3.138	3.155	3.171	3.188	3.205	3.222	3.238	15 0	21 0
	10	8	50	.072	.090	.107	.124	.141	.159	.176	.193	.211	.228	.245	10	20 50
	20		40	.072	.090	.108	.126	.144	.162	.180	.198	.216	.234	.252	30	40
	30		30	.072	.091	.109	.128	.147	.165	.184	.202	.221	.240	.259	30	30
	40		20	.072	.091	.110	.130	.149	.168	.187	.206	.226	.245	.265	40	20
	50		10	.072	.092	.111	.132	.151	.171	.190	.210	.230	.250	.271	50	10
4	0	8	0	3.072	3.092	3.112	3.133	3.153	3.173	3.193	3.214	3.234	3.255	3.276	16 0	20 0
	10	7	50	.072	.093	.113	.135	.155	.176	.196	.217	.238	.260	.281	10	19 50
	20		40	.072	.093	.114	.136	.157	.178	.199	.220	.242	.264	.285	20	40
	30		30	.072	.094	.115	.137	.159	.180	.202	.223	.245	.268	.289	30	30
	40		20	.072	.094	.116	.138	.160	.182	.204	.226	.248	.271	.293	40	20
	50		10	.072	.095	.117	.139	.161	.184	.206	.229	.251	.274	.296	50	10
5	0	7	0	3.072	3.095	3.117	3.140	3.162	3.185	3.207	3.231	3.253	3.277	3.299	17 0	19 0
	10	6	50	.072	.095	.118	.141	.163	.186	.209	.233	.255	.279	.302	10	18 50
	20		40	.072	.095	.118	.141	.164	.187	.210	.234	.257	.281	.304	20	40
	30		30	.072	.095	.118	.142	.165	.188	.211	.235	.258	.282	.306	30	30
	40		20	.072	.095	.118	.142	.165	.188	.211	.236	.259	.283	.307	40	20
	50		10	.072	.095	.118	.142	.165	.189	.212	.236	.260	.284	.308	50	10
6	0	6	0	3.072	3.095	3.118	3.142	3.165	3.189	3.212	3.236	3.260	3.284	3.308	18 0	18 0

TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 0°.

R. A. for + δ.			0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	R. A. for — δ.	
h.	m.	h. m.	s.	s	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m.	h. m.
12	0	24 0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	0 0	12 0
	10	23 50	.072	.071	.070	.069	.068	.067	.065	.064	.063	.062	.061	10	11 50
	20	40	.072	.070	.068	.066	.064	.062	.059	.057	.055	.053	.051	20	40
	30	30	.072	.069	.066	.063	.060	.057	053	.050	.047	.044	.041	30	30
	40	20	.072	.068	.064	.060	.056	.052	.047	.043	.039	.035	.031	40	20
	50	10	.072	.067	.062	.057	.052	.047	.041	.036	.031	.026	.021	50	10
13	0	23 0	3.072	3.066	3.060	2.054	3.048	3.042	3.035	3.029	3.023	3.017	3.011	1 0	11 0
	10	22 50	.072	.065	.058	.051	.044	.037	.029	.022	.015	.008	3.001	10	10 50
	20	40	.072	.064	.056	.048	.040	.032	.024	.016	.008	3.000	2.991	20	40
	30	30	.072	.063	.054	.045	.036	.027	.018	.009	3 000	2.991	.981	30	30
	40	20	.072	.062	.052	.042	.033	.023	.013	3.003	2.993	.982	.972	40	20
	50	10	.072	.061	.050	.039	.029	.018	.007	2.996	.986	.974	.963	50	10
14	0	22 0	3.072	3.060	3.048	3.037	3.026	3.014	3.002	2.990	2.978	2.966	2.954	2 0	10 0
	10	21 50	.072	.059	.046	.034	.022	.009	2.996	.983	.971	.958	.945	10	9 50
	20	40	.072	.058	.045	.032	.019	.005	.991	.977	.964	.950	.936	20	40
	30	30	.072	.057	.043	.029	.015	3.001	.986	.971	.957	.943	.928	30	30
	40	20	.072	.057	.042	.027	.012	2.997	.981	.966	.951	.936	.920	40	20
	50	10	.072	.056	.040	.024	.009	.993	.976	.960	.945	.929	.912	50	10
15	0	21 0	3.072	3.055	3.039	3.022	3.006	2.989	2.972	2.955	2.939	2.922	2.905	3 0	9 0
	10	20 50	.072	.054	.037	.020	.003	.985	.968	.950	.933	.916	.898	10	8 50
	20	40	.072	.054	.036	.018	3.000	.982	.964	.946	.928	.910	.891	20	40
	30	30	.072	.053	.034	.016	2.997	.979	.960	.941	.923	.904	.885	30	30
	40	20	.072	.053	.035	.014	.995	.976	.956	.937	.918	.899	.879	40	30
	50	10	.072	.052	.032	.012	.993	.973	.953	.933	.913	.894	.873	50	10
16	0	20 0	3.072	3.052	3.031	3.011	2.991	2.971	2.950	2.930	2.909	2.889	2.868	4 0	8 0
	10	19 50	.072	.051	.030	.009	.989	.968	.947	.926	.905	.884	.863	10	7 50
	20	40	.072	.051	.029	.008	.987	.966	.945	.923	.901	.880	.858	20	40
	30	30	.072	.050	.028	.007	.985	.964	.942	.920	.898	.876	.854	30	30
	40	20	.072	.050	.028	.006	.984	.962	.940	.918	.895	.873	.850	40	20
	50	10	.072	.050	.027	.005	.983	.960	.938	.915	.892	.870	.846	50	10
17	0	19 0	3.072	3.050	3.027	3.004	2.982	2.959	2.936	2.913	2.890	2.867	2.843	5 0	7 0
	10	18 50	.072	.049	.026	.003	.981	.958	.934	.912	.888	.865	.841	10	6 50
	20	40	.072	.049	.026	.003	.980	.957	.933	.910	.886	.863	.839	20	40
	30	30	.072	.049	.025	.002	.979	.956	.932	.909	.885	.862	.838	30	30
	40	20	.072	.049	.025	.002	.979	.956	.932	.909	.885	.861	.837	40	20
	50	10	.072	.049	.025	.002	.978	.955	.931	.908	.884	.860	.836	50	10
18	0	18 0	3.072	3.049	3.025	3.002	2.978	2.955	2.931	2.908	2.884	2.860	2.836	6 0	6 0

10.° TABLE OF PRECESSIONS IN R. A. FOR 1880.0

R. A. for + δ.				10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	R. A. for — δ.	
h.	m.	h.	m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m.	h. m.
0	0	12	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	12 0	24 0
	10	11	50	.083	.084	.085	.086	.087	.088	.089	.090	.091	.092	.094	10	23 50
	20		40	.093	.095	.097	.099	.101	.103	.105	.108	.110	.112	.115	20	40
	30		30	.103	.106	.109	.113	.116	.119	.122	.126	.129	.132	.136	30	30
	40		20	.113	.117	.121	.126	.130	.134	.138	.143	.147	.152	.157	40	20
	50		10	.123	.128	.133	.139	.144	.150	.155	.161	.166	.172	.178	50	10
1	0	11	0	3.133	3.139	3.145	3.152	3.158	3.165	3.171	3.178	3.184	3.191	3.198	13 0	23 0
	10	10	50	.143	.150	.157	.165	.172	.180	.187	.195	.202	.210	.218	10	22 50
	20		40	.152	.161	.169	.178	.186	.195	.203	.212	.220	.229	.238	20	40
	30		30	.162	.172	.181	.190	.199	.210	.219	.229	.238	.248	.258	30	30
	40		20	.171	.182	.192	.202	.212	.224	.234	.245	.255	.266	.277	40	20
	50		10	.181	.192	.203	.214	.225	.238	.249	.261	.272	.284	.296	50	10
2	0	10	0	3.190	3.202	3.214	3.226	3.238	3.251	3.263	3.276	3.289	3.302	3.315	14 0	22 0
	10	9	50	.199	.212	.225	.238	.251	.264	.277	.291	.305	.319	.333	10	21 50
	20		40	.207	.221	.235	.249	.263	.277	.291	.306	.321	.336	.351	20	40
	30		30	.215	.230	.245	.260	.275	.290	.305	.321	.336	.352	.368	30	20
	40		20	.223	.239	.254	.270	.286	.302	.318	.335	.351	.368	.385	40	30
	50		10	.231	.248	.263	.280	.297	.314	.330	.348	.365	.383	.401	50	10
3	0	9	0	3.238	3.256	3.272	3.290	3.307	3.325	3.342	3.361	3.379	3.398	3.416	15 0	21 0
	10	8	50	.245	.264	.281	.299	.317	.336	.354	.373	.392	.412	.431	10	20 50
	20		40	.252	.271	.289	.308	.327	.346	.365	.385	.405	.425	.445	20	40
	30		30	.259	.278	.297	.316	.336	.356	.376	.396	.417	.437	.458	30	30
	40		20	.265	.285	.304	.324	.344	.365	.386	.407	.428	.449	.471	40	20
	50		10	.271	.291	.311	.332	.352	.374	.395	.417	.438	.460	.483	50	10
4	0	8	0	3.276	3.297	3.318	3.339	3.360	3.382	3.404	3.426	3.448	3.471	3.494	16 0	20 0
	10	7	50	.281	.302	.324	.346	.367	.390	.412	.434	.457	.481	.504	10	19 50
	20		40	.285	.307	.329	.352	.374	.397	.419	.442	.465	.490	.514	20	40
	30		30	.289	.312	.334	.357	.380	.403	.426	.449	.473	.498	.522	30	30
	40		20	.293	.316	.339	.362	.385	.409	.432	.456	.480	.505	.530	40	20
	50		10	.296	.320	.343	.366	.390	.414	.437	.462	.486	.511	.536	50	10
5	0	7	0	3.299	3.323	3 347	3.370	3.394	3.418	3.442	3.467	3.492	3.517	3.542	17 0	19 0
	10	6	50	.302	.326	.350	.373	397	.422	.446	.471	.496	.521	.546	10	18 50
	20		40	.304	.328	.352	.376	.400	.425	.450	.475	.500	.525	.550	20	40
	30		30	.306	.330	.354	.378	.402	.427	.452	.478	.503	.528	.553	30	30
	40		20	.307	.331	.355	.380	.404	.429	.454	.480	.505	.530	.556	40	20
	50		10	.308	.332	.356	.381	.405	.430	.455	.481	.506	.531	.557	50	10
6	0	6	0	3.308	3.332	3.356	3.381	3.405	3.430	3.455	3.481	3.506	3.532	3.558	18 0	18 0

TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 10°.

R. A. for + δ.				10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	R. A. for − δ.	
h.	m.	h.	m	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m.	h. m.
12	0	24	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	0 0	12 0
	10	23	50	.061	.060	.059	.058	.057	.056	.055	.054	.053	.052	.051	10	11 50
	20		40	.051	.049	.047	.045	.043	.041	.038	.036	.034	.032	.020	20	40
	30		30	.041	.038	.034	.031	.028	.025	.021	.018	3.015	3.012	3.009	30	30
	40		20	.031	.027	.022	.018	3.014	3.010	3.005	3.001	2.996	2.993	2.988	40	20
	50		10	.021	.016	3.009	3.004	2.999	2.994	2.988	2.983	.977	.972	.967	50	10
13	0	23	0	3.011	3.005	2.997	2.991	2.985	2.979	2.972	2.966	2.959	2.953	2.946	1 0	11 0
	10	22	50	3.001	2.994	.985	.978	.971	.964	.956	.949	.941	.934	.926	10	10 50
	20		40	2.991	.983	.974	.966	.957	.949	.940	.932	.923	.915	.906	20	40
	30		30	.981	.972	.963	.953	.943	.934	.924	.913	.905	.896	.886	30	30
	40		20	.972	.962	.952	.941	.930	.920	.909	.899	.888	.877	.867	40	20
	50		10	.963	.952	.941	.929	.917	.906	.894	.883	.871	.859	.848	50	10
14	0	22	0	2.954	2.942	2.930	2.918	2.905	2.893	2.880	2.868	2.855	2.842	2.829	2 0	10 0
	10	21	50	.945	.932	.919	.906	.893	.880	.865	.852	.838	.825	.811	10	9 50
	20		40	.936	.923	.909	.895	.881	.867	.851	.837	.822	.808	.793	20	40
	30		30	.928	.914	.899	.884	.869	.854	.838	.823	.807	.792	.776	30	30
	40		20	.920	.905	.889	.874	.858	.842	.825	.809	.792	.776	.759	40	20
	50		10	.912	.896	.880	.864	.847	.830	.812	.796	.778	.761	.743	50	10
15	0	21	0	2.905	2.888	2.871	2.854	2.837	2.819	2.800	2.783	2.764	2.746	2.728	3 0	9 0
	10	20	50	.898	.880	.862	.845	.827	.809	.789	.771	.751	.732	.713	10	8 50
	20		40	.891	.873	.854	.836	.817	.798	.778	.759	.739	.719	.699	20	40
	30		30	.885	.866	.846	.827	.808	.788	.768	.748	.727	.706	.686	30	30
	40		20	.879	.859	.839	.819	.799	.779	.758	.737	.715	.694	.673	40	20
	50		10	.873	.853	.832	.812	.791	.770	.749	.727	.705	.683	.661	50	10
16	0	20	0	2.868	2.847	2.826	2.805	2.783	2.762	2.740	2.718	2.695	2.673	2.650	4 0	8 0
	10	19	50	.863	.841	.820	.798	.776	.754	.732	.709	.685	.663	.640	10	7 50
	20		40	.858	.836	.814	.792	.769	.747	.724	.702	.677	.654	.630	20	40
	30		30	.854	.832	.809	.787	.763	.741	.717	.695	.670	.646	.621	30	30
	40		20	.850	.828	.805	.782	.758	.735	.711	.688	.663	.639	.614	40	20
	50		10	.846	.824	.801	.778	.753	.730	.706	.682	.657	.633	.607	50	10
17	0	19	0	2.843	2.821	2.797	2.774	2.749	2.726	2.701	2.677	2.652	2.628	2.602	5 0	7 0
	10	18	50	.841	.818	.794	.771	.746	.722	.697	.673	.648	.623	.598	10	6 50
	20		40	.839	.816	.792	.768	.743	.719	.694	.669	.644	.619	.594	20	40
	30		30	.838	.814	.790	.766	.741	.717	.692	.666	.641	.617	.590	30	30
	40		20	.837	.813	.789	.764	.739	.715	.690	.664	.639	.615	.588	40	20
	50		10	.836	.812	.788	.763	.738	.714	.689	.663	.638	.613	.587	50	10
18	0	18	0	2.836	2.812	2.787	2.763	2.738	2.714	2.688	2.663	2.637	2.612	2.586	6 0	6 0

20°. TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

R. A. for + δ.				20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	R. A. for − δ.			
h.	m.	h.	m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	h.	m.
0	0	12	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	12	0	24	0
	10	11	50	.094	.095	.096	.097	.098	.100	.101	.102	.103	.105	.106		10	23	50
	20		40	.115	.117	.119	.122	.124	.127	.129	.132	.134	.137	.140		20		40
	30		30	.136	.139	.143	.146	.150	.154	.158	.161	.165	.169	.173		30		30
	40		20	.157	.161	.166	.171	.176	.181	.186	.191	.196	.201	.206		40		20
	50		10	.178	.183	.189	.195	.201	.207	.213	.220	.226	.233	.239		50		10
1	0	11	0	3.198	3.205	3.212	3.219	3.226	3.234	3.241	3.249	3.256	3.264	3.272	13	0	23	0
	10	10	50	.218	.227	.235	.243	.251	.260	.268	.277	.286	.295	.304		10	22	50
	20		40	.238	.248	.257	.266	.276	.286	.295	.305	.315	.326	.336		20		40
	30		30	.258	.269	.279	.289	.300	.311	.322	.333	.344	.356	.368		30		30
	40		20	.277	.289	.301	.312	.324	.336	.348	.360	.373	.386	.399		40		20
	50		10	.296	.309	.322	.334	.347	.360	.373	.387	.401	.415	.429		50		10
2	0	10	0	3.315	3.329	3.342	3.356	3.370	3.384	3.398	3.413	3.428	3.443	3.458	14	0	22	0
	10	9	50	.333	.348	.362	.377	.392	.407	.423	.438	.454	.471	.487		10	21	50
	20		40	.351	.367	.382	.398	.414	.430	.446	.463	.480	.497	.515		20		40
	30		30	.368	.385	.401	.418	.435	.452	.469	.487	.505	.523	.542		30		30
	40		20	.385	.402	.420	.437	.455	.473	.491	.510	.529	.549	.568		40		20
	50		10	.401	.419	.437	.456	.474	.493	.513	.533	.553	.573	.594		50		10
3	0	9	0	3.416	3.435	3.454	3.474	3.493	3.513	3.533	3.554	3.575	3.596	3.618	15	0	21	0
	10	8	50	.431	.451	.471	.491	.511	.532	553	.575	.596	.619	.641		10	20	50
	20		40	.445	.465	.486	.507	.528	.550	.572	.594	.617	.640	.664		20		40
	30		30	.458	.479	.501	.523	.545	.567	.590	.613	.636	.660	.685		30		30
	40		20	.471	.493	.515	.537	.560	.583	.606	.630	.655	.679	.705		40		20
	50		10	.483	.505	.528	.551	.574	.598	.622	.647	.672	.697	.723		50		10
4	0	8	0	3.494	3.517	3.540	3.564	3.588	3.612	3.637	3.662	3.688	3.714	3.741	16	0	20	0
	10	7	50	.504	.528	.551	.576	.600	.625	.651	.676	.703	.730	.757		10	19	50
	20		40	.514	.537	.562	.587	.612	.637	.663	.690	.717	.744	.772		20		40
	30		30	.522	.546	.571	.597	.624	.648	.675	.702	.729	.757	.785		30		30
	40		20	.530	.555	.580	.606	.632	.658	.685	.712	.740	.769	.798		40		20
	50		10	.536	.562	.588	.614	.640	.667	.694	.722	.750	.779	.809		50		10
5	0	7	0	3.542	3.568	3.594	3.621	3.647	3.675	3.702	3.730	3.759	3.788	3.818	17	0	19	0
	10	6	50	.546	.573	.600	.626	.653	.681	.709	.737	.766	.796	.826		10	18	50
	20		40	.550	.578	.604	.631	.658	.686	.715	.743	.772	.802	.832		20		40
	30		30	.553	.581	.608	.635	.662	.690	.719	.748	.777	.807	.838		30		30
	40		20	.556	.584	.610	.638	.665	.693	.722	.751	.780	.811	.841		40		20
	30		10	.557	.585	.612	.639	.667	.695	.724	.753	.783	.813	.843		50		10
6	0	6	0	3.558	3.586	3.613	3.640	3.668	3.696	3.724	3.754	3.783	3.813	3.844	18	0	18	0

TABLE OF PRECESSIONS IN R. A. FOR 1880.0 — 20°.

R. A. for + δ		20°	21°	22°	23°	24°	25°	26°	27°	28°	29°	30°	R. A. for — S	
h. m.	h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m.	h. m.
12 0	24 0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	0 0	12 0
10	23 50	.051	.050	.049	.048	.046	.045	.044	.043	.041	.040	.039	10	11 50
20	40	.030	.028	.025	3.023	3.020	3.018	3.015	3.013	3.010	3.008	3.005	20	40
30	30	3.009	3.005	3.002	2.998	2.995	2.991	2.987	2.983	2.980	2.976	2.972	30	30
40	20	2.988	2.983	2.979	.974	.969	.964	.959	.954	.949	.944	.938	40	20
50	10	.967	.961	.955	.950	.944	.937	.931	.925	.918	.912	.905	50	10
13 0	23 0	2.946	2.940	2.933	2.925	2.918	2.911	2.904	2.896	2.888	2.881	2.872	1 0	11 0
10	22 50	.926	.918	.910	.902	.893	.885	.876	.868	.859	.849	.840	10	10 50
20	40	.906	.897	.888	.878	.869	.859	.849	.839	.829	.819	.808	20	40
30	30	.886	.876	.866	.855	.845	.834	.823	.812	.800	.789	.777	30	30
40	20	.867	.855	.844	.833	.821	.809	.797	.784	.772	.759	.746	40	20
50	10	.848	.835	.823	.810	.797	.785	.771	.758	.744	.730	.716	50	10
14 0	22 0	2 829	2.816	2.802	2.789	2.775	2.761	2.746	2.732	2.717	2.702	2.686	2 0	10 0
10	21 50	.811	.797	.782	.767	.753	.737	.722	.706	.690	.674	.658	10	9 50
20	40	.793	.778	.763	.747	.731	.715	.698	.682	.665	.647	.630	20	40
30	30	.776	.760	.744	.727	.710	.693	.675	.658	.640	.621	.603	30	30
40	20	.759	.743	.725	.708	.690	.672	.653	.634	.615	.596	.576	40	20
50	10	.743	.726	.707	.689	.670	.651	.632	.612	.592	.572	.551	50	10
15 0	21 0	2.728	2.709	2.690	2.671	2.651	2.631	2.611	2.591	2.570	2.548	2.527	3 0	9 0
10	20 50	.713	.694	.674	.654	.634	.613	.592	.570	.548	.526	.503	10	8 50
20	40	.699	.679	.659	.638	.616	.595	.573	.551	.528	.505	.481	20	40
30	30	.686	.665	.644	.622	.600	.578	.555	.532	.508	.484	.460	30	30
40	20	.673	.652	.630	.607	.585	.562	.538	.514	.490	.465	.440	40	20
50	10	.661	.640	.617	.594	.570	.547	.522	.498	.473	.447	.421	50	10
16 0	20 0	2.650	2.628	2.605	2.581	2.557	2.532	2.508	2.482	2.457	2.431	2.404	4 0	8 0
10	19 50	.640	.617	.593	.569	.544	.519	.494	.468	.442	.415	.388	10	7 50
20	40	.630	.607	583	.558	.533	.507	.481	.455	.428	.401	.372	20	40
30	30	.621	.598	.573	.548	.522	.496	.470	.443	.416	.388	.359	30	30
40	20	.614	.590	.565	.539	.513	.487	.460	.432	.404	.376	.347	40	20
50	10	.607	.583	.557	.531	.505	.478	.451	.423	.394	.366	.336	50	10
17 0	19 0	2.602	2.577	2.551	2.524	2.497	2.470	2.443	2.414	2.386	2.357	2.327	5 0	7 0
10	18 50	.598	.571	.545	.518	.491	.464	.436	.407	.378	.349	.319	10	6 50
20	40	.594	.567	.540	.513	.486	.458	.430	.401	.372	.343	.312	20	40
30	30	.590	.564	.537	.510	.482	.454	.426	.397	.368	.338	.307	30	30
40	20	.588	.561	.534	.507	.479	.451	.423	.394	.364	.334	.303	40	20
50	10	.587	.560	.533	.505	.478	.450	.421	.392	.362	.332	.301	50	10
18 0	18 0	2.586	2.559	2.532	2.505	2.477	2.449	2.420	2.391	2.361	2.331	2.300	6 0	6 0

30°. TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

R. A. for + δ				30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	40°	R. A. for — δ	
h.	m.	h.	m.	s.	s	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m.	h. m.
0	0	12	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	12 0	24 0
	10	11	50	.106	.107	.109	.110	.112	.113	.115	.116	.118	.120	.121	10	23 50
	20		40	.140	.142	.145	.148	.151	.154	.157	.160	.163	.167	.170	20	40
	30		30	.173	.177	.181	.186	.190	.195	.199	.204	.209	.214	.219	30	30
	40		20	.206	.212	.217	.223	.229	.235	.241	.247	.254	.260	.267	40	20
	50		10	.239	.246	.253	.260	.268	.275	.283	.290	.298	.307	.315	50	10
1	0	11	0	3.272	3.280	3.289	3.297	3.306	3.315	3.324	3.333	3.343	3.352	3.363	13 0	23 0
	10	10	50	.304	.314	.324	.333	.343	.354	.364	.375	.386	.398	.410	10	22 50
	20		40	.336	.347	.358	.369	.381	.393	.405	.417	.430	.443	.456	20	40
	30		30	.368	.380	.392	.405	.417	.431	.444	.458	.472	.487	.502	30	30
	40		20	.399	.412	.425	.439	.453	.468	.483	.498	.514	.530	.548	40	20
	50		10	.429	.443	.458	.473	.489	.505	521	.538	.555	.572	.590	50	10
2	0	10	0	3.458	3.474	3.490	3.506	3.523	3.540	3.558	3.576	3.595	3.614	3.633	14 0	22 0
	10	9	50	.487	.504	.521	.539	.557	.575	.594	.614	.634	.654	.675	10	21 50
	20		40	.515	.533	.552	.570	.590	.609	.629	.650	.671	.693	.716	20	40
	30		30	.542	.561	.581	.601	.621	.642	.664	.686	.708	.731	.755	30	30
	40		20	.568	.589	.609	.630	.652	.674	.697	.720	.744	.768	.793	40	20
	50		10	.594	.615	.637	.659	.682	.705	.729	.753	.778	.804	.830	50	10
3	0	9	0	3.618	3.640	3.663	3.686	3.710	3.734	3.759	3.785	3.811	3.838	3.866	15 0	21 0
	10	8	50	.641	.665	.688	.712	.737	.762	.788	.815	.842	.870	.899	10	20 50
	20		40	.664	.688	.712	.737	.763	.789	.816	.844	.872	.902	.932	20	40
	30		30	.685	.710	.735	.761	.788	.815	.843	.872	.901	.931	.962	30	30
	40		20	.705	.730	.757	.784	.811	.839	.868	.898	.928	.959	3.991	40	20
	50		10	.723	.750	.777	.805	.833	.862	.892	.922	.953	3.985	4.018	50	10
4	0	8	0	3.741	3.768	3.796	3.824	3.853	3.883	3.914	3.945	3.977	4.010	4.044	16 0	20 0
	10	7	50	.757	.785	.813	.842	.872	.903	.934	.966	3.999	.033	.067	10	19 50
	20		40	.772	.800	.829	.859	.890	.921	.953	3.985	4.019	.053	.089	20	40
	30		30	.785	.814	.844	.875	.905	.937	.970	4.003	.037	.073	.109	30	30
	40		20	.798	.827	.857	.888	.920	.952	.985	.019	.054	.090	.126	40	20
	50		10	.809	.838	.869	.900	.932	.965	3.999	.033	.068	.105	.142	50	10
5	0	7	0	3.818	3.848	3.879	3.911	3.943	3.977	4.011	4.045	4.081	4.118	4.156	17 0	19 0
	10	6	50	.826	.857	.888	.920	.953	.986	.021	.056	.092	.129	.168	10	18 50
	20		40	.832	.863	.895	.927	.960	3.994	.029	.065	.101	.139	.177	20	40
	30		30	.838	.869	.901	.933	.966	4.000	.035	.071	.108	.146	.185	30	30
	40		20	.841	.873	.905	.937	.971	.005	.040	.076	.113	.151	.190	40	20
	50		10	.843	.875	.907	.940	.973	.007	.043	.079	.116	.154	.193	50	10
6	0	6	0	3.844	3.876	3.908	3.941	3.974	4.008	4.044	4.080	4.117	4.155	4.194	18 0	18 0

TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 30°

R. A. for + δ		30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	40°	R. A. for + δ.	
h. m.	h. m.	s	s	s	s	s	s	s	s	s	s	s	h. m.	h. m.
12 0	24 0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	0 0	12 0
10	23 50	.039	.037	.036	3.034	3.035	3.032	3.030	3.028	3.027	3.025	3.023	10	11 50
20	40	3.005	3.002	3.000	2.997	2.994	2.991	2.988	2.985	2.981	2.978	2.975	20	40
30	30	2.972	2.968	2.963	.959	.955	.950	.946	.941	.936	.931	.926	30	30
40	20	.938	.933	.927	.922	.916	.910	.904	.897	.891	.884	.878	40	20
50	10	.905	.898	.892	.884	877	.870	.862	.854	.846	838	.830	50	10
13 0	23 0	2.872	2.864	2.856	2.848	2.839	2.830	2.821	2.812	2.802	2.792	2.782	1 0	11 0
10	22 50	.840	.831	.821	.811	.801	.791	.780	.769	.758	.747	.735	10	10 50
20	40	.808	.798	.787	.775	.764	.752	.740	.728	.715	.702	.689	20	40
30	30	.777	.765	.753	.740	.727	.714	.701	.687	.673	.658	.643	30	30
40	20	.746	.733	.719	.705	.691	.677	.662	.647	.631	.615	.598	40	20
50	10	.716	.701	.687	.671	.656	.640	.624	.607	.590	.573	.554	50	10
14 0	22 0	2.686	2.671	2.655	2.638	2.621	2.604	2.587	2.569	2.550	2.531	2.511	2 0	10 0
10	21 50	.658	.641	.623	.606	.588	.569	.550	.531	.511	.491	.470	10	9 50
20	40	.630	.612	.593	.574	.555	.535	.515	.495	.473	.451	.429	20	40
30	30	.603	.583	.564	.544	.523	.503	.481	.459	.436	.413	.389	30	30
40	20	.576	.556	.535	.514	.493	.471	.448	.425	.401	.377	.351	40	20
50	10	.551	.530	.508	.486	.463	.440	.416	.392	.367	.341	.314	50	10
15 0	21 0	2.527	2.504	2.482	2.458	2.435	2.410	2.386	2.360	2.334	2.307	2.279	3 0	9 0
10	20 50	.503	.480	.456	.432	.408	.382	.356	.330	.302	.274	.245	10	8 50
20	40	.481	.457	.432	.407	.382	.355	.328	.301	.272	.243	.213	20	40
30	30	.460	.435	.410	.384	.357	.329	.302	.273	.244	.214	.182	30	30
40	20	.440	.414	.388	.361	.334	.305	.277	.247	.217	.186	.153	40	20
50	10	.421	.395	.368	.340	.312	.283	.253	.223	.191	.159	.126	50	10
16 0	20 0	2.404	2.377	2.349	2.320	2.291	2.262	2.231	2.200	2.168	2.135	2.101	4 0	8 0
10	19 50	.388	.360	.331	.302	.272	.242	.211	.179	.146	.112	.077	10	7 50
20	40	.372	.344	.315	.285	.255	.224	.192	.159	.126	.091	.056	20	40
30	30	.359	.330	.301	.270	.239	.208	.175	.142	.107	.072	.036	30	30
40	20	.347	.318	.287	.256	.225	.193	.160	.126	.091	.055	.018	40	20
50	10	.336	.306	.276	.244	.212	.180	.146	.112	.076	.040	2.002	50	10
17 0	19 0	2.327	2.296	2.265	2.234	2.201	2.168	2.134	2.099	2.063	2.027	1.989	5 0	7 0
10	18 50	.319	.288	.257	.225	.192	.158	.124	.089	.053	.015	.977	10	6 50
20	40	.312	.281	.250	.217	.184	.150	.116	.080	.044	2.006	.968	20	40
30	30	.307	.276	.244	.212	.178	.144	.109	.073	.037	1.999	.960	30	30
40	20	.303	.272	.240	.208	.174	.140	.105	.069	.032	.994	.955	40	20
50	10	.301	.270	.238	.205	.171	.137	.102	.066	.029	.991	.952	50	10
18 0	18 0	2.300	2.269	2.237	2.204	2.171	2.136	2.101	2.065	2.028	1.990	1.951	6 0	6 0

40° TABLE OF PRECESSIONS IN R. A. FOR 1880.0

R. A. for + δ		40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	R. A. for − δ	
h. m.	h. m.	s	s	s	s	s	s	s	s	s	s	s	h. m.	h. m.
0 0	12 0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	12 0	24 0
10	11 50	.121	.123	.125	.127	.129	.131	.133	.135	.137	.139	.142	10	23 50
20	40	.170	.174	.177	.181	.185	.189	.193	.197	.202	.206	.211	20	40
30	30	.219	.224	.230	.235	.241	.247	.253	.259	.266	.273	.280	30	30
40	20	.267	.274	.281	.289	.297	.305	.313	.321	.330	.339	.349	40	20
50	10	.315	.324	.333	.342	.352	.362	.372	.383	.394	.405	.417	50	10
1 0	11 0	3.363	3.373	3.384	3.395	3.407	3.418	3.431	3.443	3.457	3.470	3.485	13 0	23 0
10	10 50	.410	.422	.434	.447	.461	.474	.489	.503	.519	.535	.551	10	22 50
20	40	.456	.470	.484	.499	.514	.530	.546	.563	.580	.598	.617	20	40
30	30	.502	.517	.533	.549	.566	.584	.602	.621	.641	.661	.682	30	30
40	20	.546	.564	.581	.599	.618	.637	.657	.678	.700	.722	.746	40	20
50	10	.590	.609	.628	.648	.669	.690	712	.734	.758	.783	.808	50	10
2 0	10 0	3.633	3.653	3.674	3.696	3.718	3.741	3.765	3.789	3.815	3.841	3.869	14 0	22 0
10	9 50	.675	.697	.719	.742	.766	.791	.816	.843	.870	.899	.928	10	21 50
20	40	.716	.739	.763	.787	.813	.839	.866	.895	.924	3.954	3.986	20	40
30	30	.755	.780	.805	.831	.858	.886	.915	.945	3.976	4.009	4.042	30	30
40	20	.793	.819	.846	.874	.902	.932	3.962	3.994	4.027	.061	.096	40	20
50	10	.830	.857	.885	.914	.944	3.976	4.008	4.041	.076	.111	.149	50	10
3 0	9 0	3.866	3.894	3.924	3.954	3.985	4.018	4.051	4.086	4.122	4.160	4.199	15 0	21 0
10	8 50	.899	.929	.960	3.992	4.024	.058	.093	.129	.167	.206	.247	10	20 50
20	40	932	.963	3.994	4.027	.061	.096	.133	.171	.210	.250	.293	20	40
30	30	.962	3.994	4.027	.061	.097	.133	.171	.210	.250	.292	.336	30	30
40	20	3.991	4.024	.058	.094	.130	.167	.206	.247	.289	.332	.378	40	20
50	10	4.018	.053	.088	.124	.161	.200	.240	.281	.325	.369	.416	50	10
4 0	8 0	4.044	4.079	4.115	4.152	4.190	4.230	4.271	4.314	4.358	4.404	4.452	16 0	20 0
10	7 50	.067	.103	.140	.178	.217	.258	.300	.344	.389	.437	.486	10	19 50
20	40	.089	.126	.163	.202	.242	.284	.327	.372	.418	.466	.516	20	40
30	30	.109	.146	.184	.224	.265	.307	.351	.397	.444	.493	.544	30	30
40	20	.126	.164	.203	.244	.286	.329	.373	.419	.468	.518	.570	40	20
50	10	.142	.181	.220	.261	.304	.347	.393	.440	.489	.539	.592	50	10
5 0	7 0	4.156	4.195	4.235	4.277	4.319	4.364	4.410	4.457	4.507	4.558	4.611	17 0	19 0
10	6 50	.168	.207	.248	.290	.333	.378	.424	.472	.522	.574	.628	10	18 50
20	40	.177	.217	.258	.301	.344	.389	.436	.484	.535	.587	.641	20	40
30	30	.185	.225	.266	.308	.352	.398	.445	.494	.544	.597	.652	30	30
40	20	.190	.230	.272	.314	.359	.404	.452	.501	.552	.604	.660	40	20
50	10	.193	.233	.275	.318	.362	.408	.455	.505	.556	.609	.664	50	10
6 0	6 0	4.194	4.234	4.276	4.319	4.363	4.409	4.457	4.506	4.557	4.610	4.666	18 0	18 0

TABLE OF PRECESSIONS IN R. A. FOR 1880.0. 40°.

R. A. for + δ.		40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	R. A. for — δ.	
h.	m.	s	s	s	s	s	s	s	s	s	s	s	h.	m.
12	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	0	0
	10	3.023	3.022	3.020	3.018	3.016	3.014	3.012	3.010	3.008	3.005	3.003		10
	20	2.975	2.971	2.967	2.964	2.960	2.956	2.952	2.947	2.943	2.938	2.933		20
	30	.926	.921	.915	.910	.904	.898	.892	.885	.878	.872	.864		30
	40	.878	.871	.863	.856	.848	.840	.832	.823	.814	.805	.796		40
	50	.830	.821	.812	.803	.793	.783	.773	.762	.751	.739	.727		50
13	0	2.782	2.772	2.761	2.750	2.738	2.726	2.714	2.701	2.688	2.674	2.660	1	0
	10	.735	.723	.710	.697	.684	.670	.656	.641	.626	.610	.593		10
	20	.689	.675	.661	.646	.631	.615	.599	.582	.565	.546	.527		20
	30	.643	.628	.612	.595	.578	.561	.543	.524	.504	.484	.463		30
	40	.598	.581	.564	.545	.527	.507	.487	.466	.445	.422	.399		40
	50	.554	.536	.516	.497	.476	.455	.433	.410	.387	.362	.337		50
14	0	2.511	2.491	2.470	2.449	2.427	2.404	2.380	2.356	2.330	2.303	2.276	2	0
	10	.470	.448	.426	.403	.379	.354	.329	.302	.274	.246	.216		10
	20	.429	.406	.382	.357	.332	.305	.278	.250	.221	.190	.158		20
	30	.389	.365	.340	.313	.286	.258	.230	.200	.168	.136	.102		30
	40	.351	.325	.299	.271	.242	.213	.182	.151	.118	.084	2.048		40
	50	.314	.287	.259	.230	.200	.169	.137	.104	.069	2.033	1.996		50
15	0	2.279	2.251	2.221	2.191	2.159	2.127	2.093	2.059	2.022	1.985	1.946	3	0
	10	.245	.215	.185	.153	.120	.087	.052	2.015	1.978	.938	.898		10
	20	.213	.182	.150	.117	.083	.048	2.012	1.974	.935	.894	.852		20
	30	.182	.150	.117	.083	.048	2.012	1.974	.935	.894	.852	.808		30
	40	.153	.120	.086	.051	2.015	1.977	.938	.898	.856	.813	.767		40
	50	.126	.092	.057	2.021	1.983	.945	.905	.863	.820	.775	.729		50
16	0	2.101	2.066	2.030	1.993	1.954	1.914	1.873	1.831	1.786	1.740	1.693	4	0
	10	.077	.041	2.005	.966	.927	.886	.844	.801	.755	.708	.659		10
	20	.056	2.019	1.981	.942	.902	.861	.818	.773	.727	.678	.628		20
	30	.036	1.999	.960	.921	.880	.837	.793	.748	.701	.651	.600		30
	40	.018	.980	.941	.901	.859	.816	.771	.725	.677	.627	.575		40
	50	2.002	.964	.924	.883	.841	.797	.752	.705	.656	.606	.553		50
17	0	1.989	1.950	1.910	1.868	1.825	1.781	1.735	1.687	1.638	1.587	1.533	5	0
	10	.977	.938	.897	.855	.812	.767	.721	.673	.623	.571	.517		10
	20	.968	.928	.887	.845	.801	.756	.709	.660	.610	.558	.503		20
	30	.960	.920	.879	.836	.792	.747	.700	.651	.600	.548	.493		30
	40	.955	.915	.873	.830	.786	.740	.693	.644	.593	.540	.485		40
	50	.952	.911	.870	.827	.783	.737	.689	.640	.589	.536	.481		50
18	0	1.951	1.910	1.869	1.826	1.781	1.735	1.688	1.639	1.587	1.534	1.479	6	0

50°. TABLE OF PRECESSIONS IN R. A. FOR 1880.0.

R. A. for + δ.				50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	R. A. for — δ.			
h.	m.	h.	m.	s	s	s	s	s	s	s	s	s	s	s	h.	m.	h.	m.
0	0	12	0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	12	0	24	0
	10	11	50	.142	.144	.147	.150	.153	.156	.159	.162	.166	.169	.173		10	23	50
	20		40	.211	.216	.221	.227	.233	.239	.245	.252	.259	.266	.274		20		40
	30		30	.280	.288	.296	.304	.313	.322	.331	.341	.352	.363	.375		30		30
	40		20	.349	.359	.369	.380	.392	.404	.417	.430	.444	.459	.474		40		20
	50		10	.417	.430	.443	.456	.471	.486	.501	.518	.535	.554	.574		50		10
1	0	11	0	3.485	3.500	3.515	3.532	3.549	3.567	3.585	3.605	3.626	3.648	3.672	13	0	23	0
	10	10	50	.551	.569	.587	.606	.626	.646	.668	.691	.716	.741	.769		10	22	50
	20		40	.617	.637	.658	.679	.702	.725	.750	.777	.804	.833	.864		20		40
	30		30	.682	.704	.727	.751	777	.803	.831	.860	.891	3.924	3.959		30		30
	40		20	.746	.770	.796	.822	.850	.879	.910	3.942	3.977	4.013	4.051		40		20
	50		10	.808	.835	.862	.892	.922	3.954	3.983	4.023	4.060	.100	.142		50		10
2	0	10	0	3.869	3.898	3.928	3.959	3.992	4.027	4.063	4.102	4.142	4.185	4.230	14	0	22	0
	10	9	50	.928	3.959	3.992	4.026	4.061	.098	.137	.178	.222	.268	.317		10	21	50
	20		40	3.986	4.019	4.054	.090	.128	.167	.209	.253	.300	.349	.401		20		40
	30		30	4.042	.077	.114	.152	.193	.235	.279	.326	.375	.427	.482		30		30
	40		20	.096	.134	.172	.213	.255	.300	.346	.396	.448	.503	.561		40		20
	50		10	.149	.188	.228	.271	.316	.362	.411	.463	.518	.576	.637		50		10
3	0	9	0	4.199	4.240	4.282	4.327	4.374	4.422	4.474	4.528	4.585	4.646	4.710	15	0	21	0
	10	8	50	.247	.290	.334	.380	.429	.480	.534	.590	.650	.713	.780		10	20	50
	20		40	.293	.337	.383	.431	.482	.535	.591	.649	.711	.777	.846		20		40
	30		30	.336	.382	.430	.480	.532	.587	.645	.706	.770	.838	.909		30		30
	40		20	.378	.425	.474	.527	.580	.636	.696	.759	.825	.895	4.969		40		20
	50		10	.416	.465	.516	.569	.624	.683	.744	.809	.877	.949	5.025		50		10
4	0	8	0	4.452	4.502	4.551	4.609	4.666	4.726	4.789	4.855	4.925	4.999	5.078	16	0	20	0
	10	7	50	.486	.537	.590	.646	.705	.766	.830	.898	4.970	5.046	.126		10	19	50
	20		40	.516	.569	.623	.680	.740	.803	.869	.938	5.011	.089	.171		20		40
	30		30	.544	.598	.653	.711	.772	.836	.904	4.974	.049	.128	.212		30		30
	40		20	.570	.624	.680	.740	.802	.867	.935	5.007	.083	.163	.248		40		20
	50		10	.592	.647	.704	.764	.827	.893	.963	.035	.113	.194	.281		50		10
5	0	7	0	4.611	4.667	4.725	4.786	4.850	4.917	4.987	5.061	5.139	5.222	5.309	17	0	19	0
	10	6	50	.628	.684	.743	.804	.869	.936	5.007	.082	.161	.245	.333		10	18	50
	20		40	.641	.698	.758	.820	.885	.953	.024	.100	.179	.264	.353		20		40
	30		30	.652	.709	.769	.831	.897	.965	.037	.113	.194	.278	.368		30		30
	40		20	.660	.717	.777	.840	.905	.974	.047	.123	.204	.289	.379		40		20
	50		10	.664	.722	.782	.845	.911	.980	.053	.129	.210	.295	.386		50		10
6	0	6	0	4.666	4.723	4.784	4.847	4.912	4.982	5.054	5.131	5.212	5.297	5.388	18	0	18	0

TABLE OF PRECESSIONS IN R. A. 1880.0. 50°.

R. A. for $+\delta$		50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	R. A. for $-\delta$.	
h. m.	h. m.	s	s	s	s	s	s	s	s	s	s	s	h. m.	h. m.
12 0	24 0	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	3.072	0 0	12 0
10	23 50	3.003	3.000	2.998	2.995	2.992	2.989	2.986	2.983	2.979	2.975	2.971	10	11 50
20	40	2.933	2.928	.923	.918	.912	.906	.899	.893	.886	.878	.871	20	40
30	30	.864	.857	.849	.841	.832	.823	.814	.804	.794	.782	.770	30	30
40	20	.796	.786	.775	.764	.753	.741	.728	.715	.701	.686	.670	40	20
50	10	.727	.715	.702	.688	.674	.659	.643	.627	.609	.591	.571	50	10
13 0	23 0	2.660	2.645	2.629	2.613	2.596	2.578	2.559	2.540	2.519	2.496	2.473	1 0	11 0
10	22 50	.593	.576	.558	.539	.519	.498	.476	.453	.429	.403	.376	10	10 50
20	40	.527	.508	.487	.466	.443	.419	.394	.368	.341	.311	.280	20	40
30	30	.463	.441	.417	.393	.368	.342	.314	.285	.254	.221	.186	30	30
40	20	.399	.375	.349	.323	.295	.265	.235	202	.168	.132	.094	40	20
50	10	.337	.310	.282	.253	.223	.191	.157	.122	.084	2.045	2.003	50	10
14 0	22 0	2.276	2.247	2.217	2.185	2.152	2.118	2.081	2.043	2.003	1.960	1.915	2 0	10 0
10	21 50	.216	.185	.153	.119	.081	2.046	2.007	1.966	1.923	.877	.828	10	9 50
20	40	.158	.125	.091	2.055	2.017	1.977	1.935	.892	.845	.796	.744	20	40
30	30	.102	.067	2.031	1.992	1.952	.910	.866	.819	.770	.718	.663	30	30
40	20	2.048	2.011	1.972	.932	.890	.845	.798	.750	.697	.642	.584	40	20
50	10	1.996	1.957	.916	.874	.829	.782	.733	.682	.627	.569	.508	50	10
15 0	21 0	1.946	1.905	1.862	1.818	1.771	1.722	1.671	1.617	1.559	1.499	1.435	3 0	9 0
10	20 50	.898	.855	.811	.764	.716	.665	.611	.555	.495	.432	.365	10	8 50
20	40	.852	.808	.762	.713	.663	.610	.554	.495	.433	.368	.298	20	40
30	30	.808	.763	.715	.665	.612	.558	.500	.439	.375	.307	.235	30	30
40	20	.767	.720	.671	.619	.565	.508	.449	.386	.320	.250	.176	40	20
50	10	.729	.680	.629	.576	.520	.462	.401	.336	.268	.196	.119	50	10
16 0	20 0	1.693	1.643	1.590	1.536	1.479	1.419	1.356	1.289	1.219	1.145	1.067	4 0	8 0
10	19 50	.659	.608	.555	.499	.440	.379	.314	.246	.174	.099	1.018	10	7 50
20	40	.628	.576	.521	.464	.405	.342	.276	.207	.133	.056	0.974	20	40
30	30	.600	.547	.491	.433	.372	.308	.241	.170	.096	1.017	.933	30	30
40	20	.575	.521	.464	.405	.343	.278	.210	.138	.062	0.982	.896	40	20
50	10	.553	.498	.440	.380	.317	.251	.182	.109	.032	.950	.864	50	10
17 0	19 0	1.533	1.478	1.419	1.359	1.295	1.228	1.158	1.084	1.006	0.923	0.836	5 0	7 0
10	18 50	.517	.461	.402	.340	.276	.208	.137	.062	0.984	.900	.812	10	6 50
20	40	.503	.446	.387	.325	.260	.192	.120	.045	.965	.881	.792	20	40
30	30	.493	.435	.376	.313	.248	.179	.107	.031	.951	.866	.777	30	30
40	20	.485	.428	.368	.305	.239	.170	.098	.022	.941	.856	.766	40	20
50	10	.481	.423	.363	.300	.234	.165	.092	.016	.935	.850	.759	50	10
18 0	18 0	1.479	1.421	1.361	1.298	1.232	1.163	1.090	1.014	0.933	0.847	0.757	6 0	6 0

XIV. DETERMINATION OF THE VALUE OF ONE REVOLUTION OF THE SCREW OF A SPHEROMETER MADE BY FAUTH AND CO., OF WASHINGTON, BY C. M. CONRADSON.

The spherometer is figured in position on page 42. It consists of a light German silver tripod carrying a steel micrometer screw. The weight of the whole spherometer is about one and a half ounces. The three legs are made of steel, and screw into the German silver frame. Their points are not hardened. The angle of these points is about 35°; of the point of the micrometer screw about 60°. All slack-motion of the screw is taken up by by a second nut. Those who are interested can see a figure of a similar device in the Article Micrometer in the Encyclopædia Britannica. vol XVI, page 244, figure 5 (*n n*).

CONSTANTS OF THE SPHEROMETER.

We may call the three legs of the tripod *a, b, c; a,* is the leg to which the scale for reading whole revolutions is fixed, *b* is next to *a* in the order of decreasing readings of the micrometer head.

r′= distance from center of screw to leg *a*=1.30 inches.
r″=distance from center of screw to leg *b*=1.32 inches.
r‴= distance from center of screw to leg *c*=1.31 inches.
h′= distance which can be measured *above* the plane *abc*=0.50 inches.
h″= distance which can be measured *below* the plane *abc*=0.25 inches.

Diameter of screw=0.16 inches; 100 threads to the inch (approximately); length of nut=0.54 inches.

The distances from leg to leg are: *ab*=2.295 inches, *bc*=2.220 inches; *da*=2.290 inches. The radius of the circle, through the legs is therefore 1.310 inches, and the center of the micrometer screw is therefore 0.010 from the centre of the circle through the legs.

OBSERVATIONS.

The observations consisted in measurement of the heights of two brass cylinders with plane ends, the property of Prof. HARKNESS, U. S. Navy, and kindly lent by him. The large

cylinder is denoted by A; the small cylinder by B. The logarithms of the heights of the two cylinders in inches are respectively 9.41486 and 9.69787.* The corrections to the heights of A. and B. for temperature have been neglected, as being almost inappreciable. The whole range of temperture was less than 7°. The zero of the spherometer was determined by taking readings upon a true plane of metal. The observations were made by taking a set of ten readings upon one of the cylinders, then a set of ten upon the plane surface, and then a set of ten upon the other cylinder, so that there are thirty measures in a complete set.

Table I contains a summary of these measures. The columns headed A and B contain the heights of the two cylinders in terms of a revolution of the spherometer screw. Each value as there given is the mean of ten measures.

TABLE I.

No.	Date.	Temp.	A.	B.	No.	Date.	Temp.	A.	B.
	1882.	F.	r.	r.		1882.	F.	r.	r.
1	Sep. 28	67°	49.7864	25.9551	13	Oct. 4	68°	49.7829	25.9499
2	28	68	.7834	.9548	14	4	69	.7810	.9464
3	28	65	.7850	.9561	15	11	64	.7814	.9541
4	28	66	.7874	.9541	16	11	64	.7803	.9523
5	29	66	.7862	.9566	17	11	63	.7794	.9462
6	29	67	.7849	.9507	18	11	64	.7793	.9424
7	29	67	.7845	.9527	19	12	65	.7814	.9450
8	30	66	.7832	.9499	20	12	65	.7861	.9426
9	30	67	.7826	.9505	21	12	65	.7819	.9429
10	Oct. 2	70	.7869	.9536	22	12	65	.7779	.9402
11	2	69	.7846	.9496	23	12	66	.7827	.9454
12	Oct. 3	69	49.7841	25.9536	24	Oct. 12	66	49.7809	25.9420

*See Washington Astronomical Observations for 1877, Appendix I, page 6.

Table II contains the probable error of the measures from which the results in Table I are derived.

TABLE II.

No.	A. p. e. of the mean of ten measures.	A. p. e. of a single measure.	B. p. e. of the mean of ten measures.	B. p. e. of a single measure.
	r.	r.	r.	r.
1	±0.0001	±0.0003	±0.0005	±0.0014
2	.0005	.0015	.0005	.0015
3	.0005	.0015	.0008	.0024
4	.0003	.0009	.0006	.0017
5	.0005	.0014	.0004	.0014
6	.0006	.0020	.0007	.0021
7	.0005	.0014	.0004	.0013
8	.0008	.0025	.0007	.0021
9	.0008	.0025	.0006	.0020
10	.0009	.0028	.0008	.0023
11	.0007	.0021	.0009	.0028
12	.0002	.0007	.0005	.0014
13	.0005	.0014	.0003	.0010
14	.0005	.0017	.0007	.0022
15	.0005	.0017	.0008	.0024
16	.0005	.0016	.0009	.0026
17	.0006	.0020	.0004	.0011
18	.0006	.0019	.0006	.0020
19	.0007	.0023	.0006	.0019
20	.0005	.0016	.0006	.0019
21	.0009	.0029	.0007	.0020
22	.0005	.0016	.0009	.0026
23	.0010	.0032	.0008	.0025
24	±0.0012	±0.0037	±0.0005	±0.0016

One revolution is about 0.01 inches.

From the data in Table I and the height of the cylinder in inches, the individual determinations of one revolution of the spherometer screw in inches are deduced. These follow, in Table III.

TABLE III.

	One Revolution.			One Revolution.	
No.	Temp.	A.	B.	Temp.	A.	B.
	°	in.	in.	°	in.	in.
1	67	0.010018	0.010015	68	0.010018	0.010017
2	68	.010018	.010015	69	.010019	.010018
3	65	.010018	.010014	64	.010018	.010015
4	66	.010017	.010015	64	.010019	.010016
5	66	.010018	.010014	63	.010019	.010018
6	67	.010018	.010016	64	.010019	.010020
7	67	.010018	.010016	65	.010018	.010019
8	66	.010018	.010017	65	.010018	.010019
9	67	.010018	.010016	65	.010018	.010019
10	70	.010018	.010015	65	.010019	.010024
11	69	.010018	.010017	66	.010018	.010018
12	69	0.010018	0.010015	66	0.010019	0.010020

In the course of the measures on cylinder B it was discovered that the two plane surfaces were not parallel to each other at all points. The results derived from the measures on B are assumed to be entitled to half weight. From an inspection of Table III, it will be seen that the range of temperature is too small to allow us to deduce a temperature co-efficient, and consequently taking the mean of the individual values we have.

One revolution = 0.010018 inches at 66 ° Fahr.

The probable error of this result is not above 0.000001 in. The observations were made in the most careful way and with every precaution against constant errors.

In connection with the foregoing work, a series of measures was made by Mr. CONRADSON, to determine the length of a PRATT and WHITNEY standard half-inch belonging to Professor HOLDEN. These measures and their results are given in Table IIII.

TABLE IV.

No.	Date.	Temp.	Revolutions,	Inches.
	1883.	°	r	in
1	Jan. 8	60	49.8973	0.499873
2	8	60	.8956	.499854
3	8	59	.8981	.499879
4	8	59	.8980	.499878
5	8	59	.8988	.499886
6	8	59	.8995	.499893
7	8	59	.8989	.499888
8	8	58	.8960	.499869
9	8	58	.8980	.499889
10	Jan. 10	53	49.9000	0.499899

The length of this end-measure is then 0.499881 in., at 58° F. log 9.698867.

The probable error of the result is about 0.000003 in.

XV. ON A NEW METHOD OF OBSERVING WITH THE PRIME VERTICAL TRANSIT, BY GEORGE C. COMSTOCK.

More than half a century ago BESSEL introduced into practical astronomy the observation of stars by reflection from mercury, and the method has come into common use in meridian observations, but so far as I am aware, it has never been applied to transits over the prime vertical.* It is the purpose of this article to indicate the value of such observations and to develop the formulæ for their reduction.

Let a and b denote the altitude and azimuth of the point in which the rotation axis of a transit instrument, mounted approximately in the prime vertical, intersects the celestial sphere when produced toward the north. Denote by A, t, and z the azimuth, hour-angle, and zenith-distance of a star at the instant of its transit over a thread whose angular distance north of the collimation axis is c. Azimuths will be reckoned from the north point towards the east, and hour-angles from the meridian towards the west. Let T be the true sidereal time of transit of a star whose co-ordinates are α and δ, over the thread c.

The general equation of the transit instrument as developed by BESSEL (*Astr. Nach.* 6, p. 221; *Abh.* 64, vol. ii, p. 45), furnishes the relation

$$\text{sin. z cos. b cos (A—a)} + \cos z \sin b + \sin c = 0 \quad (1.)$$

between these quantities. Developing the first term of this equation and substituting for sin z cos A and sin z sin A their values in terms of φ, δ, and t, we shall have for each observed wire an equation of the form

$$\cos\delta \sin\varphi \cos t - \cos\delta \operatorname{tg} a \sin t = \sin\delta \cos\varphi + \frac{\cos z \sin b}{\cos a \cos b} + \frac{\sin c}{\cos a \cos b} \quad (2.)$$

which expresses the relation among the quantities for both direct and reflex observations. These several equations may

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*The method was proposed and its advantages stated in Washington Astronomical Observations for 1845, page [ix] but no practical application of it was made at Washington.—E. S. H.

be united into one by the method given in BESSEL's article above cited. If n denote the number of threads observed at a transit of the star over one vertical, the mean of the n resulting equations will be

$$\cos\delta \sin\varphi \frac{1}{n}\Sigma\cos t - \cos\delta \operatorname{tg} a \frac{1}{n}\Sigma\sin t = \sin\delta\cos\varphi + \sin b \frac{1}{n}\Sigma\cos z \quad \frac{1}{n}\Sigma\sin c \quad (3.$$
$$\cos a \cos b \qquad \cos a \cos b$$

For any thread, t is found from the equation

$$t = T - \alpha.$$

$$\text{Put } \tau = \frac{1}{n}\Sigma T - \alpha. \qquad h = t - \tau = T - \frac{1}{n}\Sigma T$$

and the first member of equation (3) becomes

$$(\cos\delta \sin\varphi \cos\tau - \cos\delta \operatorname{tg} a \sin\tau)\frac{1}{n}\Sigma\cos h -$$
$$(\cos\delta \sin\varphi \sin\tau + \cos\delta \operatorname{tg} a \cos\tau)\frac{1}{n}\Sigma\sin h$$

Assume the auxiliary quantities.

$$q\cos\psi = \sin\varphi \qquad \frac{1}{k}\cos K = \frac{1}{n}\Sigma\cos h$$
$$q\sin\psi = \operatorname{tg} a \qquad \frac{1}{k}\sin K = -\frac{1}{n}\Sigma\sin h$$

and the preceeding expression becomes

$$\frac{\cos\delta\sin\varphi\cos(\tau+\psi-K)}{k\cos\psi} = \sin\delta\cos\varphi + \frac{\sin b\frac{1}{n}\Sigma\cos z}{\cos a\cos b} + \frac{\frac{1}{n}\Sigma\sin c}{\cos a\cos b} \quad (5)$$

The quantities k and K are easily obtained with the argument h from the tables given by BESSEL and reproduced in CHAUVENET's Spherical Astronomy.

$$k = 1 + \frac{1}{n}\Sigma\frac{2\sin^2\frac{1}{2}h}{\sin 1''}.\sin 1''$$

$$K = \frac{\frac{1}{n}\Sigma(h - \sin h)}{\sin 1''}.$$

The equation (5.) is readily transformed into

$$\text{Sin}\,(\varphi - \delta) = \cos\delta \sin\varphi\, 2 \sin {}^{2}\tfrac{1}{2}\,(\tau + \psi - K)$$
$$+ \frac{\sin\ \text{b}\ \frac{1}{\text{n}}\ \Sigma \cos \text{z}}{\cos\,\text{a}\,\cos\,\text{b}} + \frac{\frac{1}{\text{n}}\Sigma \sin\,\text{c}}{\cos\,\text{a}\,\cos\,\text{b}}$$
$$-\cos\delta \sin\varphi \cos\,(\tau + \psi - K)\ \frac{1 - \text{k}\,\cos\psi}{\text{k}\,\cos\psi}$$

The last term in this expression may be made to disappear by computing the quantity.

$$\sigma = \cot\,(\tau + \psi - K)\left[\frac{2 \sin {}^{2}\tfrac{1}{2}\,\psi}{\sin\ 1''} - \frac{1}{\text{n}}\ \Sigma\ \frac{2 \sin {}^{2}\tfrac{1}{2}\,\text{h}}{\sin\ 1''}\right]$$

By the aid of which (6) is transformed into

$$\sin\,(\varphi - \delta) = \cos\delta \sin\varphi\, 2 \sin {}^{2}\tfrac{1}{2}\,(\tau + \psi - K - \sigma)$$
$$+ \frac{\sin\,\text{b}\,\frac{1}{\text{n}}\ \Sigma\ \cos\,\text{z}}{\cos\,\text{a}} + \frac{\frac{1}{\text{n}}\ \Sigma \sin\,\text{c}}{\cos\,\text{a}} \quad (7)$$

in which cos b has been put equal to 1.

By observing a star at its transit over the east and west verticals and by reversing the instrument between the transits, errors of azimuth, collimation and thread intervals may be eliminated, and errors of level are the only ones of a systematic character with which the results of a well arranged series of prime vertical transits are affected. Equation (7.) shows that if an equal number of threads are observed direct and reflected, this source of error will also be removed, since in that case Σ cos z will differ very little from zero, and being multiplied by the small quantity b, it may usually be assumed zero.

Should an extreme case require it Σ cos z is easily computed from the readings of the setting circle.

The advantages of a broken transit for reflex observations are obvious and the formula shows that the principal flexure term of such an instrument, which is of the form f cos z, is also eliminated.

The reduction of the reflex observations will be made in precisely the same way as the direct ones, the observed times T, both direct and reflex, being united into one mean thus avoiding the necessity of reducing each wire separately.

Formula (7) has been developed for the case of a transit over one vertical in order to show that the inclination of the axis may be eliminated for each vertical by a proper combination of observations and that no assumption need be made in regard to the stability of the instrument in level between the transits over the east and west verticals.

The formulae for the ordinary case of a transit over both the east and west verticals are easily derived from the preceding equations.

$$\text{Put } \tau_1 = \frac{1}{n}\Sigma T_1 - K_1 - \sigma_1 - \alpha$$

$$\tau_2 = \frac{1}{n}\Sigma T_2 - K_2 - \sigma_2 - \alpha$$

in which the subscripts 1 and 2 refer respectively to the transits over the east and west verticals. We have then:

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi [1 - \cos(\tau_1 + \psi)] + \frac{\frac{1}{n}\Sigma \cos z_1}{\cos a} b_1 \sin 1'' + \frac{\frac{1}{n}\Sigma c_1}{\cos a} \sin 1''$$

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi [1 - \cos(\tau_2 + \psi)] + \frac{\frac{1}{n}\Sigma \cos z_2}{\cos a} b_2 \sin 1'' + \frac{\frac{1}{n}\Sigma c_2}{\cos a} \sin 1''$$

Denoting by γ_1 and γ_2 the sum of the terms depending upon b and c for the east and west transits respectively, the mean of these equations gives

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi \left[1 - \cos\left(\frac{\tau_2 + \tau_1}{2} + \psi\right) \cos\left(\frac{\tau_2 - \tau_1}{2}\right)\right] + \frac{\gamma_2 + \gamma_1}{2} \quad (8.)$$

$$\text{Put now } \omega = \cot\tfrac{1}{2}(\tau_2 - \tau_1) \frac{2\sin^2\frac{1}{2}\left(\frac{\tau_2 + \tau_1}{2} + \psi\right)}{\sin 1''}$$

And equation 8 becomes

$$\sin(\Phi - \delta) = \cos\delta \sin\varphi \; 2\sin^2\tfrac{1}{2}\left(\frac{\tau_2 - \tau_1}{2} + \omega\right) + \tfrac{1}{2}(\gamma_2 + \gamma_1) \quad (9.)$$

The term $\frac{1}{2}(\gamma_2 + \gamma_1)$ may be made to disappear by properly combining the observations. as has been already indicated.

If the instrument is properly adjusted, the quantity ψ in the expression for ω may be neglected, and the formulæ reduced to

$$\omega = \cot \tfrac{1}{2}(\tau_2 - \tau_1) \frac{2 \sin^2 \tfrac{1}{2} \frac{\tau_2 + \tau_1}{2}}{\sin 1''}$$

$$\sin(\varphi - \delta) = \cos\delta \sin\varphi \, 2 \sin^2 \tfrac{1}{2} \left(\frac{\tau_2 - \tau_1}{2} + \omega \right)$$

For $\frac{\tau_2 \quad 1}{2}$ we may write $\frac{1}{2}\left(\frac{1}{n} \Sigma T_2 + \frac{1}{n} \Sigma T_1\right) - \alpha$ and for

$\frac{\tau_2 - \tau_1}{2}$, $\frac{1}{2}\left[\left(\frac{1}{n} \Sigma T_2 - \sigma_2 - K_2\right) - \left(\frac{1}{n} \Sigma T_1 - \sigma_1 - K_1\right) \right]$

in which the quantities K_1 and K_2 will usually be insensible.

It is evident that those stars for which $\varphi - \delta$ is very small; cannot be observed in the prime vertical by reflection, and it is a matter of some interest to know how great must be the difference between the declination and latitude to allow such observations to be made. This will depend mainly upon the distance from the objective of the telescope at which the mercury basin can be placed. A simple geometrical construction will show that the limiting value of z for which the reflected rays from the star will fall upon every portion of the objective is given approximately by the equation $\sin z = \frac{a}{2d}$.

Where a is the diameter of the object end of the telescope and d is the vertical distance of the center of the objective above the reflecting surface. From the figures contained in the *Description de l'Observatoire de Pulkova* and the first volume of the *Washington Observations*, I have computed for the prime vertical instruments of those two observatories the limiting values of $\varphi - \delta$ within which reflex observations cannot be made in the prime vertical, using for d the distance from the objective to the floor when the telescope is pointed to the nadir. I find for

Pulkova, $\varphi - \delta = 0.^\circ 6$ $z = 6.^\circ 1$.
Washington, $\varphi - \delta = 0.2$ $z = 3.9$.

The quantity z is the corresponding zenith distance in the prime vertical.

In investigations in which the highest degree of accuracy is sought, such as the determination of the constant of aberration, annual parallax, etc., the elimination of the inclination of the rotation axis is a matter of prime importance, and the increased labor of the observations will be well repaid by the removal of one source of error. In the case of field instruments of the ordinary construction the limits of declination imposed upon the method may be such as to prevent its convenient application, but with the *Steinheil* broken transit, in which the objective and ocular are at the extremities of the axis, I see no reason why it should not be employed in the field.

OCTOBER, 1883.

XVI. INVESTIGATION OF THE MICROMETER OF THE FIFTEEN INCH EQUATORIAL, BY MR. JOHN TATLOCK.

The screw of this micrometer, which was made by CLARK, was investigated by Professor HOLDEN at Washington in February 1881, on the "Ruled Glass Scale Micrometer," belonging to the United States Naval Observatory. The method of making the observations is fully detailed in the *Washington Observations* for 1877.—Appendix I. The observations have been reduced by Mr. TATLOCK.

The value of one revolution of the screw of this Micrometer is $10''.48$. The object of the investigation was: *First*: To determine the inequalities of the several whole revolutions from 43^r to 87^r. *Second*: To determine the periodic errors of the part of the screw most used. *Third*: To determine the length of the mean revolution in inches at 32° Fahrenheit. Table I contains the corrections required to reduce each revolution of the screw to the mean value of a single revolution derived from all the observations. Table I*a* contains these corrections for those revolutions which were twice measured, and the mean of the two.

The probable error of each single correction in these tables is $\pm\ 0''.02$.

These tables especially the table I*a*, show that the data are not sufficient to determine definitive corrections to each whole revolution, and they also show that such corrections are very small.

To determine the periodic inequalities of the screw, the length of every tenth of a revolution was determined. Table II contains the residuals found by subtracting the individual values of one-tenth revolution from the mean value. The probable error of a single measure is about $0''.02$, and of the mean of 10 about $0''.006$.

TABLE I.

Revolutions.	Corrections.	Revolutions.	Corrections.	Revolutions.	Corrections.
r r	″	r r	″	r r	″
43—44	—0.063	58—59	—0.021	73—74	+0.021
44—45	+0.042	59—60	—0.031	74—75	—0.042
45—46	—0.052	60—61	+0.105	75—76	+0.021
46—47	0.000	61—62	—0.021	76—77	0.000
47—48	—0.021	62—63	—0.021	77—78	—0·021
48—49	+0.042	63—64	+0.031	78—79	+0.063
49—50	+0.031	64—65	—0.084	79—80	—0.105
50—51	—0.042	65—66	—0.010	80—81	+0.021
51—52	—0.031	66—67	+0.031	81—82	+0.094
52—53	—0.010	67—68	+0.021	82—83	—0.031
53—54	—0.052	68—69	+0.010	83—84	+0.042
54—55	—0.021	69—70	+0.010	84—85	—0.063
55—56	+0.084	70—71	—0.021	85—86	—0.042
56—57	—0.052	71—72	—0.010	86—87	+0.042
57—58	—0.010	72—73	+0·063		

TABLE I*a*.

Revolutions.	Corrections.	Corrections.	Mean.
r. r.	″	″	″
63—64	+0.031	—0.021	+0.005
64—65	—0.084	+0.021	—0.031
65—66	—0.010	0.000	—0.005
66—67	+0.031	+0.010	+0.020
67—68	+0.021	0.000	+0.010
70—71	—0.031	0.000	—0.015
71—72	—0.021	—0.021	—0.021
72—73	+0.052	+0.021	+0.036

TABLE II.

Rev.	0 to .1.	.1 to .2.	.2 to .3.	.3 to .4.	.4 to .5.	.5 to .6.	.6 to .7.	.7 to .8.	.8 to .9.	.9 to 0.0
	"	"	"	"	"	"	"	"	"	"
63	0.000	—0.010	—0.021	—0.010	+0.021	—0.031	+0.010	—0.010	+0.021	+0.031
64	+0.010	+0.031	+0.010	+0.010	—0.073	+0.052	0.000	+0.021	—0.031	+0.010
65	+0.021	+0.031	+0.021	+0.052	+0.010	—0.010	—0.031	+0.042	—0.010	0.000
66	—0.031	+0.021	+0.031	+0.010	—0.052	+0.010	0.000	+0.010	+0.031	—0.021
67	+0.010	0.000	0.000	+0.021	—0.031	—0.021	0.000	+0.031	+0.010	0.000
68	—0.042	+0.031	+0.031	+0.010	0.000	+0.052	—0.063	+0.010	—0.010	+0.031
69	0.000	+0.010	—0.021	+0.010	+0.031	—0.010	+0.031	—0.021	+0.010	0.000
70	+0.010	—0.021	+0.031	+0.021	+0.031	—0.031	—0.010	+0.031	—0.021	+0.021
71	—0.031	+0.031	+0.031	0.000	—0.031	0.000	+0.010	+0.010	0.000	—0.021
72	+0.031	—0.010	+0.031	—0.021	+0.010	0.000	—0.021	+0.010	+0.021	—0.010
Σ	—0.022	+0.114	+0.144	+0.103	—0.084	+0.011	—0.074	+0.134	+0.021	+0.041
No. obs.	10	10	10	10	10	10	10	10	10	10
Mean.	—0.002	+0.011	+0.014	+0.010	—0.008	+0.001	—0.007	+0.013	+0.002	+0.004

If we assume that the correction for the periodic error of the screw can be expressed by an equation of the form $m = a \sin u + b \cos u$ where m is the correction, u is the angle through which the screw is turned, and a and b coefficients, and if we determine the values of a and b from the data in Table II, we shall find that the maximum value of the correction does not amount to 0″.02. We may safely say that the periodic inequalities of this screw, from 63^r to 73^r, are far less than the accidental errors of the measures which can be made with it, and need not be further considered.

In order to determine the value of the mean revolution of the screw in inches, we assume the coefficient of expansion of the steel screw, which is 0.00000680, so that the length of one revolution of the screw at t° Fahrenheit is (assuming its length at 32° Fahrenheit as unity), 1+0.00000680 (t°—32°), or 1+[4.832509] (t°—32°).

TABLE III. LENGTH OF ONE REVOLUTION IN INCHES.

Date, 1881.	Temperature.	Limiting Revolutions.	No. of Revolutions.	No. of Scale Divisions.	No. of Revolutions at 32° Fr.	No. of inches at 32° Fr.	1 Revolution at 32° Fr.	Wt.
	°	r r		d	r	in.	in.	
Feb. 15	59.0	78—85	7	4.408	7.001285	0.087673	0.01250	1
15	59.0	85—88	3	1.892	3.000551	0.037630	0.01254	1
15	59.0	43—88	45	27.717	46.008262	0.551277	0.01225	9
16	60.0	43—46	3	1.891	3.000571	0.037611	0.01254	1
16	61.0	46—53	7	4.399	7.001380	0.087495	0.01250	1
16	61.0	53—59	6	3.775	6.001183	0.075084	0.01250	1
16	62.0	59—65	6	3.770	6.001224	0.074985	0.01250	1
16	62.0	65—72	7	4.393	7.001428	0.087376	0.01248	1
16	62.0	72—78	6	3.764	6.001224	0.074865	0.01248	1
18	59.0	63—69	5.8	3.640	5.801065	0.072398	0.01248	1
21	64.0	69—73	3.7	2.320	3.700805	0.046145	0.01247	1
21	64.5	43—88	4.5	27.716	45.009945	0.552053	0.01226	9
25	58.5	20—45	24.649	15.499	24.653442	0.308625	0.01251	5

Taking the mean by weights, we conclude that the value of one revoiution in inches at 32° F. = 0.012369, log. 8.092335.

The focal length of the telescope at 32° F. is then 243.44. in.

INVESTIGATION OF THE POSITION CIRCLE.

The position circle of the micrometer was investigated by Mr. TATLOCK, on February 10, 1884, by setting Vernier A at every 10° of the circle and noting the corresponding readings of Vernier B. These observations are given in the following table. Each reading there set down is the mean of three separate settings and readings.

Ver. A	Ver. B		Ver. A	Ver. B		Ver. A	Ver. B	
°	°	′	°	°	′	°	°	′
0	179	56.0	120	299	56.7	240	59	56.7
10	189	55.3	130	309	54.0	250	69	56.7
20	199	55.7	140	319	55.7	260	79	57.0
30	209	55.3	150	329	55.3	270	89	55.7
40	219	55.0	160	339	56.0	280	99	57.3
50	229	55.0	170	349	56.0	290	109	58.0
60	239	54.3	180	359	56.0	300	119	57.0
70	249	54.7	190	9	57.0	310	129	58.7
80	259	54.3	200	19	56.3	320	139	58.7
90	269	54.7	210	29	56.7	330	149	56.3
100	279	55.3	220	39	57.0	340	159	56.7
110	289	54.7	230	49	56.3	350	169	56.3

Where the observations are recorded to the nearest 0°.1, as is usual, either vernier may be employed. For readings to single minutes both verniers must be read.

XVII. METEOROLOGICAL OBSERVATIONS AT MADISON, DURING 1882–1883.

In continuation of the data for the years 1872–1881, inclusive, given in *Publications of the Washburn Observatory*, Vol. I, page 169, *et seq.*, I give here the data for the years 1882 and 1883. From 1882 January 1, to 1883 March 31, they are derived from observations taken at the U. S. Signal Station, in the City of Madison, by the Signal Observer, Mr. C. A. SHAW. On 1883, April 1, the Signal Station in Madison was abandoned, and the instruments were transferred to the University. They were temporarily mounted on the roof of the North Dormitory and the observations of 1883 May 1 to 1883 July 31, were made there by Mr. J. C. OFFICER, a student at the University.

In August they were mounted at the Observatory, where they will remain. The observations of August to December 12, 1883, were made by Mr. TATLOCK, assistant, and since then by Mr. GEORGE W. BROWN, a student in the University.

The instruments are 1st, a large Signal Service Wind Vane. This is mounted on the east wing and the arrow is some forty feet above the ground. The exposure is good except that the dome makes a lee for westerly winds. The small vane on the Student's Observatory can be used as a check. The large vane is read by means of a dial and pointer in the ceiling of the bed room assigned to the meteorological observer.

2d. A ROBINSON'S anemometer on the southeast angle of the building. Its revolving cups are 38 feet above the ground. It is in the lee of the dome (some 70 feet distant) for westerly winds. The anemometer is of the Signal Service pattern and automatically registers each mile of wind traveled on a chronograph barrel in the hall.

3d. A rain guage is placed on the roof near the anemometer. It is 24 feet above the ground. A rain guage on the ground has also been read at times.

4th. Two mercurial barometers are hung in the clock room. Their cisterns are 961 feet above sea level. The observatory barometer has been moved to the Meridian Circle room.

5th. Wet and dry bulb thermometers are placed in the Thermometer Shelter outside of the Meridian Circle room. These instruments are the property of the U. S. Signal Service, and are additional to the instruments of the Observatory described in vol. I., p. 31. The observations are made at 7 A. M., 2 P. M., and 9 P. M. daily, local mean time.

It should be noticed that the mean daily barometer and the mean daily thermometer relate to the civil day beginning at 12 midnight. The Maximum and Minimum thermometers relate to the day from 9 P. M. to 9 P. M. The maximum velocity of wind, and the number of miles traveled by the wind relate to the day from 2 P. M. to 2 P. M.

METEOROLOGICAL RECORD FOR THE MONTH OF JANUARY, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	29.097	22	7	15.3	22	220	.....
2	29.078	24	15	17.3	9	122	.01
3	29.285	25	10	17.3	14	181	.....
4	29.381	25	18	21.0	22	262	—*
5	29.236	35	19	27.0	15	150	.....
6	28.920	37	24	31.3	15	218	.10
7	28.796	38	31	35.0	15	207	.06
8	28.805	35	23	29.7	24	309	.02
9	29.128	41	24	33.0	20	228	.....
10	28.986	37	29	32.7	12	131	.49
11	29.188	34	23	28.7	16	188	.15
12	29.190	32	9	22.7	12	106	.....
13	28.802	35	8	24.0	28	245	.06
14	28.854	26	—5	14.3	23	297	.....
15	28.815	33	20	25.3	24	228	.....
16	29.191	22	1	5.0	25	249	.....
17	29,155	17	—6	5.7	20	268	.....
18	28.940	27	9	17.0	24	329	.....
19	29.132	30	6	19.0	15	172	.....
20	28.881	37	17	31.0	14	196	—*
21	28.990	35	14	25.0	32	342	—*
22	29.482	15	2	6.7	24	288	.....
23	29.627	7	—8	—0.3	13	209	.....
24	29.186	29	3	21.7	18	243	.02
25	28.661	42	28	37.7	17	256	.09
26	28.651	48	26	37.0	38	278	.33
27	29.090	41	19	32.0	16	213	.....
28	29.108	36	3	15.7	32	462	.....
29	29.348	19	—1	11.3	24	281	.....
30	28.919	38	16	27.3	25	328	.....
31	28.676	34	23	27.7	12	174	.....
Means.	29.052	30.8	13.1	22.4	Sums.	7480	1.33

Highest barometer, 29,679 in.; lowest, 28.307 in.; highest temperature, 48°; lowest —8.0°, maximum velocity of wind, 38 miles; prevailing winds S., N. W. and W.; No. of cloudy days, 10; No. of fair days, 17; No. of clear days, 4; range of thermometer, 56°; range of barometer, 1.372 in.

Memoranda. No. of times wind blew from N., 3; E., 3; S., 25; W.. 17; N. E., 8; S. E, 10; S. W., 11; N. W., 16. (Observed every eight hours.)

*Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF FEBRUARY, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.824	35	26	30.0	25	329	.....
2	28.892	40	24	32.0	25	341	.....
3	28.939	48	22	34.3	25	278	.....
4	28.757	37	25	31.3	25	287	.....
5	28.828	42	30	34.7	24	206	——*
6	29.804	54	30	42.3	17	219	.....
7	28.939	46	25	34.0	25	326	.....
8	29.034	41	22	30.0	15	177	.....
9	28.897	47	24	35.0	28	250	.....
10	29.168	44	27	36.0	19	248	.....
11	28.961	51	35	43.7	20	295	.01
12	28.764	63	45	51.0	30	389	.....
13	29.012	46	29	35.7	25	338	.....
14	28.976	49	29	38.0	19	246	.....
15	28.851	56	34	43.3	20	319	.....
16	28.932	54	32	39.3	20	218	.....
17	29.503	30	16	22.7	24	414	——*
18	29.088	40	25	34.0	23	398	.63
19	29.135	39	20	27.3	22	326	.03
20	28.797	28	17	24.7	27	379	.08
21	28.595	28	16	19.7	30	450	.25
22	29.030	16	4	10.0	20	352	.....
23	29.241	26	10	19.3	13	202	.....
24	29.375	36	13	24.3	13	133	.....
25	29.150	46	27	39.0	20	311	.05
26	29.044	44	38	40.7	14	134	.04
27	28.803	47	37	43.3	24	257	.34
28	28.473	47	40	43.3	16	186	.22
Means.	28.958	42.2	25.8	35.5	Sums..	8008	1.74

Highest barometer, 29.605 in.; lowest, 28.332 in. Highest temperature, 63°; lowest, 4°. Maximum velocity of wind, 30 miles. Prevailing winds, S., W., S. W., S. E. No. of cloudy days, 8; No. of fair days, 13; No. of clear days, 7. Range of thermometer, 59°. Range of barometer, 1·273 in.

Memoranda: No. times the wind blew from the N., 2; E., 4; S., 23; W., 18; N. E., 4; S, E., 13; S. W., 14; N. W., 4. (Observations once in eight hours.

*Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF MARCH, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.709	62	37	47.7	18	213	.....
2	29.040	61	37	45.3	20	175	.....
3	29.248	50	34	40.3	13	188	.....
4	28.867	43	33	38.3	33	519	.58
5	28.757	43	32	35.7	25	385	.....
6	29.148	32	23	25.3	22	356	—*
7	29.550	29	15	22.0	17	249	—*
8	29.287	36	23	30.0	13	211	.13
9	28.833	30	25	26.7	34	484	.66
10	29.200	35	25	29.7	20	257	.....
11	29.090	33	26	29.3	15	181	.05
12	28.865	33	22	26.7	24	301	.01
13	29.092	34	17	25.7	20	278	—*
14	29.059	39	27	32.3	21	274	.25
15	28.982	37	32	34.7	16	218	.05
16	29.232	40	31	35.7	20	184	.....
17	28.841	38	34	36.7	25	449	.32
18	28.800	49	35	39.0	22	270	.08
19	29.104	48	30	39.0	15	158	.....
20	28.664	43	35	38.7	28	418	.74
21	28.652	39	19	34.3	32	503	.07
22	29.258	39	22	29.7	30	372	—*
23	29.130	49	22	34.0	30	443	.....
24	29.331	35	14	23.7	28	276	.....
25	28.846	43	31	36.0	25	326	.35
26	28.516	49	35	39.7	12	118	.95
27	28.691	43	33	36.7	25	415	.49
28	29.762	50	32	41.7	28	372	.....
29	28.723	58	36	45.0	28	514	.....
30	29.361	41	27	32.3	25	318	.....
31	29.143	57	31	43.3	24	309	.....
Means.	28.993	42.5	28.2	34.4	Sums.	9734	4.73

Highest barometer, 29.584 inches; lowest, 28.319 inches; highest temperature, 62°; lowest, 14°; maximum velocity of wind, 34 miles; prevailing winds, N. W., S. E., N. E., W.; No. of cloudy days, 13; No. of fair days, 18; No. of clear days, 0; range of thermometer, 48°; range of barometer, 1.265 inches.

Memoranda: No. of times wind blew from the N. 12; E. 12; S. 7; W. 12; N. E., 6; S. E., 13; S. W. 6; N. W., 25. (Observations once in eight hours.)

*Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF APRIL, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.834	78	46	62.0	18	256	.12
2	29.104	70	48	55.7	25	202	.....
3	29.019	73	41	59.0	20	275	.02
4	29.063	66	34	45.7	25	331	.17
5	29.059	42	33	38.0	21	332	.48
6	28.702	68	41	54.7	44	449	.37
7	29.106	60	43	47.7	16	239	.....
8	29.034	56	40	46.0	32	346	.06
9	28.885	48	34	40.7	28	449	1.29
10	29.146	34	24	28.7	32	448	—*
11	29.186	39	22	28.3	16	238	.....
12	29.130	44	29	37.3	10	148	.....
13	29.111	45	34	40.0	11	143	.....
14	29.155	48	34	39.0	15	175	.....
15	29.125	55	33	43.0	9	142	.....
16	29.175	58	37	46.0	12	168	.....
17	29.126	65	41	52.0	15	235	.....
18	28.709	58	45	49.0	30	297	1.35
19	28.415	50	39	44.0	35	490	.09
20	28.800	53	33	41.7	22	276	.....
21	28.970	54	36	42.7	20	275	.....
22	28.878	44	39	40.7	30	477	.07
23	29.026	51	37	42.3	16	384	.....
24	29.211	53	33	42.7	20	265	.....
25	29.103	57	37	46.0	20	266	.....
26	28.939	56	40	47.7	18	236	.19
27	28.949	65	43	53.0	30	313	—*
28	29.099	53	43	44.3	20	282	.....
29	29.134	56	40	44.3	25	256	.....
30	29.075	57	35	45.7	16	221	.....
Means.	29.009	55.2	37.1	44.9	Sums	8,613	4.21

Highest barometer, 29.227 in.; lowest, 28.197 in. Highest temperature, 78°; lowest, 22°. Maximum velocity of wind, 44 miles. Prevailing winds, E., N. E., W. No. of cloudy days, 10; No. of fair days, 16; No. of clear days, 4. Range of thermometer, 56°; range of barometer, 1.030 in.

Memoranda: No. times wind blew from N., 6; N. E., 17; E., 27; S. E., 3; S., 4; S. W., 11; W., 12; N. W., 10. (Observations once in 8 hours.)

*Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF MAY, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	29.043	53	38	44.3	21	367	——*
2	29.253	56	33	44.0	16	198	.....
3	28.960	57	43	50.7	17	267	.03
4	28.789	58	49	53.0	18	189	.37
5	28.877	52	40	45.0	25	410	.02
6	29.089	56	37	44.0	20	350	.....
7	29.064	60	37	50.0	20	333	.....
8	28.802	78	52	64.7	25	350	.08
9	28.700	75	62	66.7	20	311	.....
10	28.625	69	44	53.3	20	254	.69
11	28.788	44	39	40.0	24	427	.26
12	28.868	44	39	41.3	25	477	.22
13	28.942	57	41	48.3	25	414	.01
14	28.990	63	44	50.3	20	326	.....
15	29.129	57	37	47.0	18	285	.....
16	29.243	67	41	52.3	5	74	.....
17	29.274	74	46	59.0	11	120	.....
18	29.219	75	51	62.0	20	203	.....
19	29.016	68	57	62.3	18	235	——*
20	28.875	73	45	57.3	30	291	.42
21	28.965	50	43	45.0	18	274	.....
22	29.100	51	38	42.3	22	326	.....
23	29.218	59	35	44 7	14	183	.....
24	29.129	56	44	48.7	12	182	.....
25	29.038	68	43	55.3	18	199	.....
26	28.917	66	52	57.3	10	134	.09
27	28.878	56	45	49.3	20	281	.....
28	29.003	66	41	52.0	21	278	.....
29	29.032	71	44	58.0	11	154	.....
30	28.747	67	50	59.7	28	222	.25
31	28.683	62	50	54.7	26	293	.45
Means.	28.976	61.6	43.9	51.7	Sums.	8346	2.89

Highest barometer, 29.325 in.; lowest, 28.548 in.; highest temperature, 78°; lowest, 33°; maximum velocity of wind, 30 miles; prevailing winds: N. E., S.; No. of cloudy days, 13; No. of fair days, 13; No. of clear days, 5; range of thermometer, 45°; range of barometer, 0.777 in.

Memoranda: No. times wind blew from N., 9; E., 13; S., 18; W., 4; N. E., 22; S. E., 8; S. W., 10; N. W., 9. (Observations once in eight hours.)

*Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF JUNE, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.783	68	46	56.3	17	171	—*
2	28.771	60	53	54.0	14	182	.04
3	28.779	52	42	45.7	26	403	1.26
4	28.873	57	44	50.3	18	287	.04
5	29.036	73	45	59.7	15	198	.....
6	29.003	78	54	64.3	16	277	.....
7	28.850	79	58	67.7	19	289	.....
8	28.756	78	62	68.7	15	197	.25
9	28.817	80	54	67.3	12	127	.....
10	28.919	69	52	57.0	20	265	.....
11	29.107	71	45	58.3	16	276	.....
12	29.063	77	49	63.0	15	169	.....
13	28.973	77	53	66.0	15	156	.18
14	28.701	79	65	70.0	22	275	.10
15	28.812	82	63	71.3	13	241	.....
16	28.745	78	65	68.0	12	154	.56
17	28.574	83	66	69.3	18	186	.....
18	28.482	75	49	63.7	28	418	.31
19	29.047	67	47	55.7	25	315	—*
20	29.084	65	52	58.7	16	268	—*
21	29.094	70	56	62.3	13	170	.11
22	29.013	87	61	70.7	48	200	.58
23	29.024	80	64	72.0	12	127	.....
24	28.879	81	65	71.0	27	182	1.49
25	28.936	79	67	70.7	8	116	.....
26	29.057	81	64	70.7	8	118	.....
27	28.988	78	66	70.7	12	116	.63
28	28.969	75	62	68.0	13	113	.....
29	28.895	80	60	70.0	14	182	.14
30	28.674	84	67	73.7	16	252	2.07
Means.	28.889	74.8	56.5	64.5	Sums.	6412	7.76

Highest barometer, 29.137 in.; lowest, 28.361 in.; highest temperature, 87°; lowest, 42°; maximum velocity of wind, 48 miles; prevailing winds E., S. W., W.; No. of cloudy days, 10; No. of fair days, 13; No. of clear days, 7; range of thermometer, 45°; range of barometer, 0.776 in.

Memoranda. No. of times wind blew from N., 10; E., 21; S., 4; W., 15; N. E., 5; S. E. 9; S. W., 15; N. W.. 11. (Observations once in 8 hours.

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF JULY, 1882.

Day.	Mean daily barometer	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind, number of miles traveled.	Rainfall.
	inches	°	°	°	miles		inches
1	28.937	72	60	66.0	19	239	.....
2	29.087	77	55	65.7	8	102	.....
3	28.941	68	55	59.7	22	237	.91
4	29.132	70	50	59.7	22	257	—*
5	29.121	75	55	63.0	7	93	.....
6	28.963	71	60	64.3	16	214	.05
7	28.772	71	61	63.0	16	212	.33
8	28·916	78	63	68.3	7	79	.....
9	28.872	80	65	69.7	16	202	.83
10	28.816	78	57	66.7	16	228	.....
11	28.865	79	60	67.3	20	280	.....
12	28.838	70	58	62.3	20	265	.01
13	28.977	69	57	61.7	18	194	.04
14	29.122	78	50	64.7	9	114	.....
15	29.029	78	61	68.7	20	274	—*
16	28.912	78	65	69.0	17	264	.....
17	29.007	81	60	68.7	9	132	.....
18	28.936	77	59	65.7	17	258	.....
19	29.045	72	57	62.3	14	215	.....
20	29.148	76	56	61.7	19	156	—*
21	29.210	80	55	64.7	17	140	.....
22	29.257	83	61	70.7	6	73	.....
23	29.190	84	64	72.3	11	114	.....
24	29.039	85	64	73.0	15	171	.....
24	29.018	86	69	76.0	12	178	.....
26	29.018	87	67	75.7	12	170	.....
27	28.949	84	72	75.7	15	202	.01
28	29.068	78	64	68.3	12	157	.....
29	29.173	75	54	64.0	12	197	.....
30	29.084	70	58	64.0	15	224	.12
31	28.985	71	62	67.0	18	241	.40
Means.	29.914	76.7	60.0	66.8	Sums.	5884	2.70

Highest barometer, 29.293 in.; lowest, 28.754 in. Highest temperature, 87°; lowest, 50°. Maximum velocity of wind, 22 miles. Prevailing winds, W., N.W., S.W. No. of cloudy days, 4; No. of fair days, 20; No. of clear days, 7. Range of thermometer, 37°; range of barometer, 0.539 in.

Memoranda: No. times the wind blew from the N., 11; E., 10; S., 14; W., 16; N.E., 4; S.E., 8; S. W., 13; N.W., 17. (Observations once in 8 hours.)

*Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF AUGUST, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.970	77	65	66.0	13	108	.88
2	28.930	74	64	67.3	14	206	.33
3	28.911	68	63	65.3	15	275	.80
4	28.947	73	65	67.7	12	212	.07
5	29.018	80	66	71.0	12	159	.....
6	29.043	79	67	72.7	6	74	.....
7	28.919	85	68	74.0	24	176	.....
8	28.894	71	63	63.7	23	378	.....
9	29.002	61	55	57.0	23	257	.06
10	29.114	72	50	58.3	11	185	—*
11	28.969	77	55	65.7	13	242	.....
12	28.921	75	64	67.3	13	198	—*
13	28.907	82	62	70.7	16	223	.01
14	28.778	87	66	73.0	32	247	1.30
15	28.852	81	63	69.7	35	195	2 20
I6	28.975	74	60	66.0	16	219	.....
17	29.130	80	59	68.0	13	95	.....
18	29.145	82	64	72.7	8	81	.....
10	29.153	83	65	71.3	11	141	.....
20	29.220	85	67	73.7	8	118	.....
21	29.160	84	67	73.3	13	158	.....
22	29.045	82	68	75.0	9	104	—*
23	29.034	86	69	74.0	12	113	.....
24	28.984	83	67	73.3	17	121	.01
25	28.924	83	68	73.0	13	101	.04
26	28.995	82	67	72.7	11	119	.....
27	29.062	80	65	70.3	12	182	.....
28	29.060	81	63	70.7	12	167	.....
29	29.060	80	64	72.3	11	144	.....
30	29.002	72	61	64.7	18	203	1.13
31	29.062	63	58	60.3	18	301	.—*
Means.	29.006	78.1	63.5	69.1	Sums.	5502	6.83

Highest barometer, 29.248 inches; lowest, 28.725 inches; highest temperature, 87°; lowest, 50°; maximum velocity of wind, 35 miles; prevailing winds, N., E., S. W.; No. of cloudy days, 8; No. of fair days, 20; No. of clear days, 3; range of thermometer, 37°; range of barometer, 0.513.

Memoranda: No. times wind blew from the N., 18; E., 18; S. 5; W. 7; N. E., 12; S. E., 2; S. W., 17; N. W., 14. (Observations once in eight hours.)

* Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF SEPTEMBER, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind number of miles traveled.	Rainfall.
	inches.	°	°	°	miles		inches
1	29.040	62	57	59.7	10	155	.63
2	28.932	72	55	61.3	12	206	.42
3	28.988	71	58	62.0	18	240	.23
4	29.198	76	57	64.3	12	167	.....
5	29.229	80	60	67.3	6	104	.....
6	29.094	77	61	67.7	15	186	.....
7	29.007	78	63	68.3	12	109	.....
8	29.101	74	57	63.0	8	127	.....
9	29.120	79	58	65.0	10	59	.53
10	29.123	69	56	60.7	12	171	.....
11	29.092	77	49	59.7	12	205	.....
12	28.985	73	55	64.0	15	190	.....
13	28 788	80	62	68.0	10	142	.....
14	28.926	78	65	69.0	18	270	.....
15	29.107	80	55	66.0	9	115	.....
16	29.043	78	61	68.3	8	122	.....
17	28.864	83	66	72.7	12	191	.....
18	28.756	85	69	74.3	20	226	—*
19	28.936	73	56	62.7	17	260	.....
20	29.209	56	48	50.3	17	245	.....
21	29.207	57	44	49.0	13	189	.....
22	29.064	64	43	52.7	23	248	.....
23	29.224	62	44	51.0	12	196	.....
24	29.324	64	45	52.7	12	105	.06
25	29.415	63	50	55.0	12	162	.....
26	29.343	66	45	53.0	12	159	.....
27	29.099	63	47	55.0	16	209	.....
28	28.983	69	53	60.0	13	207	.....
29	29.049	66	58	60.3	13	209	.04
30	29.192	67	56	60.3	7	92	.....
Means.	29.081	71.4	55.1	61.4	Sums	5,266	1.91

Highest barometer, 29.448 in.; lowest, 28.709 in. Highest temperature, 85°; lowest, 43°. Maximum velocity of wind, 23 miles. Prevailing winds, E., W., S. No. of cloudy days, 3; No. of fair days, 19; No. of clear days, 8. Range of thermometer, 42°; Range of barometer, 0.739 inches.

Memoranda: No. of times blew from the N., 7; N. E., 11; E., 22; S. E., 10; S., 13; S. W., 6; W., 15; N. W., 6. (Observations once in 8 hours.)

*Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF OCTOBER, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind, number of miles traveled.	Rainfall.
	inches	°	°	°	miles		inches
1	29.245	65	57	60.0	7	105	—*
2	29.211	70	57	62.7	11	186	.....
3	29.204	71	58	62.3	8	188	.....
4	29.158	72	57	63.7	10	119	.....
5	29.160	78	61	67.3	14	99	.....
6	29.086	78	63	69.3	16	162	.....
7	28.889	68	63	65.3	18	179	1.56
8	28.648	68	56	61.7	21	255	.75
9	28.980	64	48	52.3	13	302	.....
10	29.028	50	43	46.3	18	156	.35
11	28.944	57	41	50.0	24	264	.....
12	28.672	67	52	49.0	22	434	.66
13	28.847	66	52	56.3	20	249	.....
14	28.973	71	51	59.7	20	271	.....
15	28.931	69	51	59.3	20	288	.....
16	28.861	61	45	50.3	15	199	.12
17	29.002	62	42	50.7	8	142	.....
18	29.183	53	40	45.7	16	261	.....
19	29.217	58	35	45.0	12	135	.....
20	29.118	53	42	51.7	11	154	.....
21	28.966	64	46	55.0	20	240	.....
22	28.976	62	46	50.0	25	271	.....
23	29.011	58	43	48.3	8	116	.....
24	28.935	65	43	53.3	16	167	.....
25	28.791	63	48	53.7	22	137	.....
26	29.112	53	39	44.7	14	152	.....
27	29.031	59	37	47.7	10	135	.....
28	28.779	54	43	47.7	15	217	.15
29	28.803	49	41	45.3	15	243	.....
30	28.572	63	47	56.0	32	276	.55
31	28.906	62	43	47.7	23	245	.....
Means.	28.975	64.9	49.4	54.5	Sums	6,456	4.14

Highest barometer, 29.281 in.; lowest, 28.419 in. Highest temperature, 78°; lowest, 35°. Maximum velocity of wind, 32 miles; Prevailing winds, S., N. W., E., S. E. No. of cloudy days, 7; No. of fair days, 15; No. of clear days, 9. Range of thermometer, 43°; range of barometer, 0.862 in.

Memoranda: No. times wind blew from N., 4; N. E., 3; E., 14; S. E., 13; S., 25; S. W., 6; W., 10; N. W., 18. (Observations once in 8 hours.)

*Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF NOVEMBER, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	″	°	Miles.		Inch's
1	29.285	56	38	44.3	13	160	.....
2	29.535	49	30	39.3	13	253	.....
3	29.326	54	37	44.7	9	102	.....
4	29.198	55	36	45.7	22	252	.....
5	28.913	51	42	45.7	22	380	1.07
6	28.890	49	46	46.3	11	131	.10
7	29.095	58	44	50.0	11	143	.....
8	29.128	53	41	45.3	14	163	.....
9	28.951	50	40	45.7	6	85	.....
10	28.840	61	48	56.3	20	215	.07
11	28.720	66	49	56.7	24	303	.61
12	28.917	49	25	28.7	23	349	.....
13	29.008	31	18	25.0	22	342	—*
14	28.826	41	27	35.7	21	279	.....
15	29.066	47	34	39.3	19	245	.....
16	29.096	42	33	37.7	16	192	.38
17	29.316	42	34	37.7	23	314	.05
18	29.281	43	37	38.7	12	139	.....
19	29.247	44	30	37.3	7	101	.....
20	29.078	44	35	39.7	12	129	.....
21	28.965	40	31	35.3	16	267	.....
22	28.877	44	33	39.3	18	175	.....
23	28.901	40	23	28.3	28	462	.18
24	29.287	30	19	24.0	25	301	.....
25	29.161	44	26	35.7	16	195	.....
26	29.036	37	25	29.7	21	334	—*
27	29.232	36	17	28.0	17	180	.....
28	29.122	35	25	30.3	18	159	.16
29	29.278	32	21	26.0	20	324	—*
30	29.073	36	26	31.3	14	220	.....
Means.	29.088	45.3	32.3	38.3	Sums.	6894	2.62

Highest barometer, 29.538 inches; lowest, 28.650 inches; highest temperature, 66°; lowest, 17°; maximum velocity of wind, 28 miles; prevailing winds, N. W., W.; No. of cloudy days, 11; No. of fair days, 15; No. of clear days, 4; range of thermometer, 49°; range of barometer, 0.938 inches.

Memoranda: No. of times wind blew from the N., 7; E.. 10; S., 12; W., 14; N. E, 8; S. E., 12; S. W., 10; N. W., 17. (Observations once in eight hours.)

* Precipitation too small to be measured.

METEOROLOGICAL RECORD FOR THE MONTH OF DECEMBER, 1882.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.877	43	29	35.0	13	144	
2	29.273	33	17	20.7	28	416	.05
3	28.992	34	18	28.7	21	251	.15
4	28.659	34	23	26.7	38	462	.01
5	28.947	27	16	21.7	23	225	
6	29.192	16	0	5.3	36	370	.09
7	29.546	0	—13	—8.3	35	473	
8	29.295	12	— 8	5.3	16	210	
9	28.812	24	12	19.0	14	211	.06
10	28.832	22	12	15.7	16	233	.05
11	28.999	27	7	19.0	14	169	.01
12	28.756	42	26	36,3	20	248	
13	28.885	32	5	14.0	23	327	
14	29.031	20	8	12.7	22	304	.03
15	29.200	8	— 4	2.7	20	398	
16	29.041	16	0	9.7	16	210	.02
17	28.882	24	11	19.0	8	116	.18
18	29.092	31	18	25.3	15	177	
19	28.883	37	24	33.7	19	260	.08
20	28.581	39	33	35.3	14	255	.80
21	28.626	38	33	35.0	10	137	.19
22	28.770	38	33	33.7	10	136	—*
23	28.855	32	25	26.7	10	173	—*
24	29.086	32	19	25.7	8	87	
25	29.140	36	23	31.7	10	135	.20
26	29.245	37	30	33.7	10	97	.03
27	29.288	36	23	26.0	10	86	.02
28	29.270	37	23	28.7	12	83	
29	29.180	28	20	24.3	13	178	
30	29.236	25	19	21.7	8	93	.05
31	29.311	22	4	8.7	15	189	.01
Means.	39.025	28.5	15.7	21.7	Sums.	6853	2.03

Highest barometer, 29.577 in.; lowest, 28.487 in.; Highest temperature, 43°; lowest, —13°; Maximum velocity of wind, 38 miles; prevailing winds, N. W., W.; No. of cloudy days, 15; No. of fair days, 12; No. of clear days, 4; range of thermometer, 56°; range of barometer, 1.090 in.

Memoranda. No. times wind blew from the N., 6; E., 7; S., 4; W., 23; N. E., 4; S. E., 15; S. W., 10; N. W., 24. (Observations taken once in 8 hours.)

* Precipitation too small to be measured.

METEOROLOGICAL SUMMARY FOR THE YEAR 1882.

Month.	Mean monthly barometer.	Mean maximum thermometer.	Mean minimum thermometer.	Mean monthly temperature.	Maximum velocity of wind.	Wind, number miles traveled.	Rainfall.
1882.	Inches.	°	°	°	Miles.		Inch's
January....	29.052	30.8	13.1	22.4	38	7,480	1.33
February...	28.958	42.2	25.8	35.5	30	8,008	1.74
March.....	28.993	42.5	28.2	34.4	34	9,734	4.73
April.....	29.009	52.5	37.1	44.9	44	8,613	4.21
May.....	28.976	61.6	43.9	51.7	30	8,346	2.89
June	28.889	74.6	56.5	64.5	48	6,412	7.76
July	29.014	76.7	60.0	66.8	22	5,884	2.70
August.....	29.006	78.1	63.5	69.1	35	5,502	6.83
September .	29.081	71.4	55.1	61.4	23	5,266	1.91
October.. ..	28.975	64.9	49.4	54.5	32	6,456	4.14
November..	29.088	45.3	32.3	38.3	28	6,894	2.62
December ..	29.025	28.5	15.7	21.7	38	6,853	2.03
Means.....	29.005	55.8	40.0	47.1	Sums.	85,448	42.89

No. days on which rain has fallen in quantities too small to be measured, 30.

Highest barometer, 29.679 in.; lowest, 28.197 in.; highest temperature, 87°; lowest, −13°; maximum velocity of wind, 48 miles; prevailing winds, N. W., W. E., S.; No. of cloudy days, 112; No. of fair days, 191; No. of clear days, 62; range of thermometer, 100°; range of barometer, 1.482 in.

Memoranda: No. times wind blew from the N., 95; E., 161; S., 154; W., 163; N. E., 104; S. E., 116; S, W., 129; N. W., 181. (Observations once in eight hours.)

NOTE — The observations for the year 1882 were taken at the U. S. Signal Station, Madison.

METEOROLOGICAL RECORD FOR THE MONTH OF JANUARY, 1883.

Day.	Mean daily barometer.	Max'mum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	29.228	22	1	9.7	10	141	.....
2	29.176	21	—2	11.3	20	195	.01
3	29.354	19	—5	2.0	20	265	.....
4	29.317	12	—5	5.7	12	208	.15
5	29.107	23	12	18.7	8	84	.04
6	28.754	28	15	21.3	20	258	.03
7	29.083	20	2	6.3	14	210	.....
8	29.231	6	— 7	2.0	19	212	.....
9	28.793	18	—12	7.0	16	173	.02
10	28.581	14	7	1.7	25	283	.19
11	29.133	18	8	11.7	15	182	—*
12	28.717	35	5	16.0	24	329	.02
13	28.747	35	— 1	29.0	23	407	.03
14	29.244	7	—11	— 1.7	16	178	.....
15	29.332	18	— 7	8.7	5	61	—*
16	29.126	26	13	19.7	6	64	.19
17	28.894	24	13	18.6	17	262	.12
18	29.184	23	— 2	14.3	11	130	.08
19	29.096	29	—10	8.0	20	311	.04
20	28.874	—5	—17	—11.3	23	265	.....
21	29.079	—12	—23	—18·0	20	268	.....
22	29.341	—12	—23	—17.0	16	220	.....
23	29.401	0	—21	—12.0	13	194	.....
24	29.162	12	— 2	5.3	16	228	.03
25	29.371	7	—10	— 0.7	11	144	.....
26	28.957	28	0	17.0	15	155	.02
27	28.980	28	18	20.7	16	166	.....
28	28.952	32	12	22.3	10	120	.....
29	28.776	30	9	19.3	8	87	—*
30	28.409	31	15	24.0	24	355	.04
31	28.947	15	—9	1.7	22	411	.....
Means.	29.043	18.3	—4.6	8.5	Sums.	6666	1.01

Highest barometer, 29.473 in.; lowest, 28.352 in.; highest temperature, 35°; lowest —23°; maximum velocity of wind, 25 miles; prevailing winds, N. W., W., S. W.; No. of cloudy days, 6; No. of fair days, 20; No. of clear days, 5; range of thermometer, 58°; range of barometer, 1.121 in.

Memoranda. No. of times wind blew from N., 6; E., 7; S., 6; W..21; N. E., 3; S. E., 7; S. W., 17; N. W., 26. (Observed every eight hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF FEBRUARY, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	29.479	0	—17	—7.7	14	191	.....
2	29.365	2	— 9	—1.3	23	297	.13
3	29.153	8	+ 2	6.0	22	413	.09
4	29.462	7	+ 8	—3.3	15	218	——*
5	29.422	14	—14	—0.7	14	180	.....
6	28.964	19	— 1	11.0	14	195	.16
7	29.015	17	+ 5	9.0	16	247	.10
8	29.166	27	3	15.0	15	246	.....
9	29.456	19	6	10.0	16	218	.....
10	29.125	23	— 3	13.3	12	152	——*
11	28.901	29	15	21.3	18	222	——*
12	29.396	29	4	15.3	10	59	.....
13	29.176	36	5	24.0	5	12	.....
14	28.632	37	30	34.0	16	121	.07
15	28.712	38	33	36.0	17	117	.07
16	28.631	49	12	34.0	28	306	.78
17	29.514	14	0	7.0	25	358	.....
18	29.487	28	1	16.7	20	248	.....
19	29.359	32	18	24.7	14	140	.....
20	29.112	33	19	27.0	24	334	.....
21	29.160	31	11	21.0	16	222	.01
22	29.065	30	18	20.7	12	131	.10
23	29.232	31	11	24.0	18	207	——*
24	28.803	33	24	28.7	17	259	.13
25	29.100	27	12	17.0	20	366	——*
26	29.455	17	7	10.7	21	292	.....
27	29.159	41	8	27.3	20	160	——*
28	29.226	47	27	35.7	15	201	.....
Means.	29.169	25.6	7.8	17.0	Sums..	6112	1.64

Highest barometer, 29.608 in.; lowest, 28.494 in. Highest temperature, 49°; lowest, —17°. Maximum velocity of wind, 28 miles. Prevailing winds, W., N. W., S. W. No. of cloudy days, 7; No. of fair days, 11; No. of clear days, 10. Range of thermometer, 66°; range of barometer, 1.114 in.

Memoranda: No. times the wind blew from the N., 6; E., 6; S., 10; W., 20; N. E., 5; S, E., 9; S. W., 12; N. W., 16. (Observations once in eight hours.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF MARCH, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Incn's
1	29.000	52	35	41.7	16	235	.....
2	29.318	39	28	31.7	16	251	.....
3	29.337	33	19	26.0	16	283	.....
4	29.321	29	23	25.3	17	193	.....
5	29.118	33	18	16.7	15	204	.03
6	28.841	31	15	24.3	30	343	.04
7	29.431	20	1	8.0	27	241	.....
8	29.144	41	9	26.7	16	198	.....
9	28.633	46	28	35.7	28	331	.....
10	28.579	30	21	25.0	28	454	.02
11	29.070	28	18	22.0	17	318	.....
12	28.940	44	17	31.3	22	316	.....
13	28.953	49	28	26.0	12	193	.....
14	28.756	53	32	40.0	29	365	.....
15	29.121	32	15	20.0	32	432	—*
16	28.936	31	16	25.0	15	199	.....
17	28.476	52	26	40.0	28	309	.....
18	28.828	47	9	20.7	32	383	.10
19	28.995	22	5	11.0	18	273	.....
20	28.934	25	7	16.0	10	117	.....
21	29.067	32	9	20.7	8	92	.....
22	28.762	37	24	28.3	32	317	—*
23	29.050	35	15	27.0	22	280	.....
24	29.068	46	23	34.0	15	201	.....
25	29.022	40	33	34.0	12	134	.03
26	29.091	33	20	26.7	15	224	.08
27	29.085	31	23	26.0	9	132	.02
28	29.055	32	21	26.7	6	42	—*
29	28.930	39	20	28.3	6	76	.....
30	28.940	41	25	30.3	15	190	.....
31	29.064	35	25	28.7	18	278	.....
Means.	28.995	36.7	19.6	27.1	Sums.	7606	0.32

Highest barometer, 29.486 inches; lowest, 28.332 inches; highest temperature, 53°; lowest, +1°; maximum velocity of wind, 32 miles; prevailing winds, N. W., N., W.; No. of cloudy days, 9; No. of fair days, 15; No. of clear days, 7; range of thermometer, 52°; range of barometer, 1.154 inches.

Memoranda: No. of times wind blew from the N. 17; N. E. 12; E. 1; S. E. 5; S. 7; W. 13; N. W., 28; S. W., 10. (Observed every eight hours.)

*Precipitation too small to measure. (N. B.— No observations in April.)

METEOROLOGICAL RECORD FOR THE MONTH OF MAY, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.	.....	Inch's
1	28.975	.....	.....	55.0	.....	.....	.10
2	28.983	.....	.....	42.0	.....	.....	1.00
3	28.969	.....	.....	39.7	.....	.....	.13
4	29.022	.....	.....	40.5	.....	.....	.08
5	29.057	.....	.....	48.3	.....	.....	.....
6	.....	.....	.....	.....	.....	.....	.....
7	.....	.....	.....	.....	.....	.....	.....
8	.....	.....	.....	.....	.....	.....	.....
9	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....
11	29.125	53	36	46.0	.....	.....	.....
12	29.106	55	39	47.7	.....	.....	.....
13	28.995	50	36	42.3	.....	.....	.80
14	28.571	45	40	41.3	.....	.....	1.70
15	28.934	57	37	52.0	.....	.....	.....
16	29.095	66	41	57.3	.....	.....	.....
17	28.936	73	47	55.0	.....	.....	.20
18	28.493	78	52	68.5	.....	.....	.32
19	28.583	89	59	63.3	.....	.....	.....
20	28.770	66	46	41.5	.....	.....	.....
21	28.938	49	33	41.0	.....	.....	.....
22	29.022	52	33	48.0	.....	.....	.....
23	28.977	65	36	58 5	.....	.....	.....
24	28.793	70	49	61.7	.....	.....	.....
25	28.753	69	52	54.7	.....	.....	1.80
26	28.769	69	47	57.5	.....	.....	.....
27	28.698	68	49	54.3	.....	.....	.05
28	28.662	66	46	55.0	.....	.....	.....
29	28.858	64	47	56.3	.....	.....	.....
30	28.809	65	48	55.3	.....	.....	.80
31	29.065	61	44	55.7	.....	.....	.....
Means.	28.883	63.5	43.7	51.5	Sums.		6.98

Highest barometer, 29.181 in.; lowest, 28.439 in.; highest temperature, 78°; lowest, 33°; prevailing winds, S. W., N. E., S; No. of cloudy days, 10; No. of fair days, 8; No. of clear days, 8; range of thermometer, 56°; range of barometer, 0.742 in.

Memoranda: No. times wind blew from N., 8; E., 7; S., 10; W., 8; N. E., 13; S. E., 8; S. W., 13; N. W., 11. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF JUNE, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	29.129	69	47	62.0	.....	.....	.....
2	28.925	74	54	63.0	.....	.....	.95
3	28.999	72	58	59.0	.....	.....	2.40
4	29.057	68	50	62.5	.....	.....	.....
5	28.874	75	55	69.0	.....	.....	.35
6	28.851	75	59	65.7	.....	.....	.08
7	28.824	75	56	66.0	.....	.....	.....
8	28.810	75	55	60.7	.....	.....	.65
9	28.715	69	54	59.5	.....	.....	.60
10	28.723	68	53	56.3	.....	.....	.....
11	28.672	71	51	65.3	.....	.....	.09
12	28.651	73	58	64.3	.....	.....	.40
13	28.998	73	51	58.0	.....	.....	.....
14	29.062	69	50	62.0	.....	.....	.....
15	28.891	73	53	65.3	.....	.....	.....
16	28.846	83	57	74.7	.....	.....	.80
17	28.735	71	62	70.7	.....	.....	—*
18	28.681	74	63	68.3	.....	.....	.80
19	28.783	76	61	65.3	.....	.....	.....
20	28.835	74	57	66.7	.....	.....	—*
21	28.718	74	61	68.0	.....	.....	.30
22	28.988	77	57	70.5	.....	.....	.....
23	28.962	80	61	72.0	.....	.....	.15
24	28.893	80	63	69.5	.....	.....	.....
25	28.930	75	53	57.5	.....	.....	.....
26	28.921	70	53	55.3	.....	.....	.....
27	28.933	73	56	65.0	.....	.....	—*
28	28.888	74	58	68.3	.....	.....	.....
29	28.831	86	52	74.3	... ...	.....	.....
30	29.034	83	60	70.3	.....	.....	.....
Means.	28.872	74.5	55.9	65.2	Sums.		7.57

Highest barometer, 29.195 in.; lowest, 28.629 in.; highest temperature, 86°; lowest, 47°; prevailing winds, N., S., S. W.; No. of cloudy days, 12; No. of fair days, 11; No. of clear days, 7; range of thermometer, 39°; range of barometer, 0.566 in.

Memoranda: No. of times wind blew from N., 19; N. E., 5; E., 3; S. E., 8; S., 17; S. W., 18; W., 9; N. W., 11. (Three observations daily.)

* Precipitation too small to measure.

METEOROLOGICAL RECORD FOR THE MONTH OF JULY, 1883.

Day.	Mean daily barometer	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind, number of miles traveled.	Rainfall.
	Inches	°	°	°	Miles		Inch's
1	28.925	83	60	75.3	.....	.....	.....
2	28.887	89	65	80.7	.....	.....	.....
3	28.828	89	69	81.3	.....	.....	.....
4	28.887	88	61	74.5	.....	.....	.88
5	28.979	88	62	75.0	.....	.....	.....
6	28.865	84	68	76.3	.....	.....	.....
7	28.922	83	59	60.7	.....	.....	.90
8	29.080	65	52	60.5	.....	.....	.....
9	29.057	72	53	66.3	.....	.....	.....
10	28.861	79	61	73.7	.....	.....	.....
11	28.776	81	67	74.7	.....	.....	.....
12	28.630	81	62	71.7	.....	.....	.35
13	28.763	79	57	68.3	.....	.....	.....
14	28.712	78	57	70.5	.....	.....	.02
15	28.813	80	58	70.7	.....	.....	.....
16	28.697	81	63	67.0	.....	.....	1.89
17	29.021	75	57	59.7	.....	.....	.....
18	29.233	69	52	64.5	.....	.....	.....
19	29.119	75	58	67.7	.....	.....	.....
20	28.852	76	60	69.5	.....	.....	.46
21	28.854	84	57	77.3	.....	.....	2.05
22	29.008	85	67	74.7	.....	.....	.30
23	28.930	83	66	68.7	.....	.....	1.16
24	28.918	75	63	70.7	.....	.....	.40
25	28.962	78	73	74.0	.....	.....	.....
26	28.925	83	67	75.7	.....	.....	.38
27	29.042	83	66	67.3	.....	.....	.10
28	29.007	69	57	65.0	.....	.....	.....
29	29.115	69	54	62.7	.....	.....	.....
30	29.170	69	54	62.7	.....	.....	.....
31*	.....	.....	.....	.....	.....	.....	.....
Means.	28.928	79.1	60.8	70.2	Sums.		8.89

Highest barometer, 29.245 in.; lowest, 28.591 in. Highest temperature, 89°; lowest, 52°. Prevailing winds, S. W., W., S. No. of cloudy days, 5; No. of fair days, 17; No. of clear days, 8. Range of thermometer, 37°; range of barometer, 0.644 in.

Memoranda: No. times the wind blew from the N., 7; E., 4; S., 14; W., 19; N. E., 5; S. E., 7; S. W., 24; N. W., 9. (Three observations daily.)

* Instruments were being moved.

METEOROLOGICAL RECORD FOR THE MONTH OF AUGUST, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's.
1*							
2	28.959	80	57	60.5	.....	.....	.40
3	29.038	66	53	59.0	.....	.....	.....
4	29.142	71	52	61.5	.....	.....	.....
5	29.249	74	54	64.0	.....	.....	.....
6	29.270	76	64	65.5	.....	.....	.....
7	29.219	78	55	64.5	.....	.....	.....
8	29.117	78	55	66.3	10	141	.....
9	29.080	78	57	66.5	8	119	.....
10	29.101	78	59	66.1	6	111	.....
11	28.957	80	58	69.4	17	158	.....
12	28.969	71	.....	64.3	16	222	.32
13	29.191	66	54	58.9	15	335	.....
14	29.219	50	52	59.9	11	157	.....
15	29.145	74	54	64.8	13	139	.....
I6	29.012	78	61	69.6	14	182	.....
17	28.940	84	69	75.9	18	188	.05
18	28.878	82	70	74.9	22	328	.....
19	28.823	86	70	74.2	20	270	.02
20	28.857	79	56	71.3	36	359	.....
21	28.799	83	61	73.4	36	374	.....
22	28.845	78	73	68.7	34	539	.....
23	29.101	79	.....	62.6	14	203	.....
24	29.137	77	55	64.6	12	125	.....
25	29.075	78	61	70.4	18	207	.....
26	29.225	73	57	61.5	.....	186	.....
27	29.015	67	51	59.6	.....	201	1.95
28	29.063	68	61	63.4	.....	272	.....
29	29.117	54	73	63.0	.....	216	.....
30	29.068	76	62	67.3	.....	228	.....
31	29.093	78	63	70.0	.....	198	.....
Means.	29.027	78.3	59.2	66.1	Sums.	5458	2.74

Highest barometer, 29.278 inches; lowest, 28.668 inches; highest temperature, 86°; lowest, 51°; maximum velocity of wind, 36 miles; prevailing winds, S. W., S., N. W.; No. of cloudy days, 8; No. of fair days, 11; No. of clear days, 11; range of thermometer, 35°; range of barometer, 0.590 in.

Memoranda: No. times wind blew from the N., 13; E., 3; S. 17; W. 4; N. E., 9; S. E., 9; S. W., 18; N. W., 16. (Three observations daily.)

*Instruments were being moved.

METEOROLOGICAL RECORD FOR THE MONTH OF SEPTEMBER, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles		Inch's
1	28.975	77	64	71.3	.....	.....	.....
2	29.106	73	62	66.0	28	191	.....
3	29.156	71	56	62.1	20	206	.....
4	29.014	72	58	62.7	24	336	.....
5	29.255	67	47	57.3	20	254	.....
6	29.025	69	50	59.6	20	211	0.93
7	28.940	64	46	50.3	36	321	.....
8	29.337	53	38	45.9	32	552	.....
9	29.405	58	39	48.1	16	172	.....
10	29.291	64	39	43.6	25	198	.....
11	29.202	70	47	58.4	16	181	.....
12	29.105	73	47	59.6	12	132	.....
13	28.999	74	48	61.9	12	118	.....
14	29.048	79	54	67.0	12	156	.....
15	28.956	80	60	69.9	16	174	.....
16	28.967	72	58	61.1	30	294	0.54
17	29.174	64	50	56.0	24	269	.....
18	29.213	66	50	55.9	12	155	.....
19	29.156	71	50	61.3	12	150	.....
20	28.971	68	58	58.6	8	102	0.66
21	28.876	58	49	52.0	28	256	.....
22	29.028	66	46	58.0	10	144	.....
23	28.837	66	58	59.3	24	164	0.05
24	28.644	60	51	55.5	20	213	0.16
25	29.033	60	45	49.2	32	355	0.05
26	28.978	61	40	51.9	24	265	.....
27	28.966	61	49	52.3	24	332	.....
28	29.109	49	42	43.0	24	335	.....
29	28.994	52	40	46.5	12	141	.....
30	28.977	55	30	45.0	18	166	.....
Means.	29.058	65.8	49.0	56.6	Sums	6,443	2.39

Highest barometer, 29.455 in.; lowest, 28.603 in. Highest temperature, 79°; lowest, 38°. Maximum velocity of wind, 36 miles. Prevailing winds, S., N., S. E., S. W. No. of cloudy days, 11; No. of fair days, 8; No. of clear days, 11. Range of thermometer, 41°; Range of barometer, 0.852 inches.

Memoranda: No. of times blew from the N., 19; N. E., 7; E., 6; S. E., 11; S., 21; S. W., 10; W., 7; N. W., 9. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF OCTOBER, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind	Wind, number of miles traveled.	Rainfall.
	Inches	°	°	°	Miles		Inch's
1	28.851	53	34	44.7	12	134	0.10
2	28.839	57	49	61.7	15	155	.....
3	29.246	49	37	41.7	16	254	.....
4	29.260	49	35	44.2	16	143	.....
5	29.030	52	46	49.3	20	264	0.13
6	29.184	53	48	51.0	20	182	.....
7	29.152	64	47	56.0	16	176	0.10
8	28.791	79	54	58.6	32	455	.....
9	28.873	71	57	61.0	48	475	0.27
10	29.121	61	52	54.2	14	114	0.61
11	29.088	60	47	54.0	12	116	.....
12	29.078	55	43	44.6	18	187	0.12
13	29.063	46	34	37.0	28	438	1.41
14	29.329	45	34	43.0	30	383	.....
15	29.551	50	34	41.0	16	163	.....
16	29.498	51	32	41.0	22	185	.....
17	29.088	56	39	51.7	28	378	.....
18	28.822	62	53	57.8	40	512	0.78
19	29.150	57	44	47.0	24	248	.....
20	29.479	44	28	33.6	26	411	.....
21	29.328	38	33	35.3	18	217	.....
22	29.295	42	34	35.9	18	179	.....
23	29.350	46	37	39.8	16	163	.....
24	29.227	40	35	38.9	26	356	.....
25	29.037	43	35	39.8	28	489	0.10
26	29.031	48	36	42.6	28	209	.....
27	28.880	47	41	44.0	20	232	.....
28	28.634	51	44	48.6	20	280	0.10
29	28.478	50	44	46.5	14	155	0.06
30	28.789	51	39	44.4	45	357	.....
31	29.060	45	33	36.9	36	426	.....
Means.	29.081	52.1	40.6	46.3	Sums	8,372	3.79

Highest barometer, 29.557 in.; lowest, 28.448 in. Highest temperature, 79°; lowest, 28°. Maximum velocity of wind, 48 miles; Prevailing winds, S. E., N., N. W. No. of cloudy days, 20; No. of fair days, 5; No. of clear days. 6. Range of thermometer, 51°; range of barometer, 1.109 in.

Memoranda: No. times wind blew from N., 15; E., 6; S., 12; W., 8; N. E., 11; S. E., 20; S. W., 7; N. W., 14 (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF NOVEMBER, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	29.253	41	29	33.8	32	406	.....
2	29.134	48	26	39.9	24	212	.....
3	28.924	55	41	46.0	28	482	.....
4	28.934	58	33	48.4	20	195	0.95
5	28.634	60	48	52.0	44	537	.....
6	29.126	49	33	36.1	26	304	0.32
7	28.891	44	31	39.3	34	277	0.05
8	28.734	55	33	45.4	28	158	.....
9	28.773	49	41	44.2	18	208	0.40
10	28.903	49	36	39.4	16	173	.....
11	29.035	46	22	29.5	48	430	.....
12	29.285	31	17	26.2	48	522	.....
13	28.832	41	21	28.1	40	521	.....
14	29.091	21	8	16.5	36	479	.....
15	29.321	24	6	9.1	32	511	.....
16	29.288	25	2	19.3	38	408	.....
17	28.999	44	22	33.0	34	559	.....
18	28.959	48	25	36.4	24	240	.....
19	28.904	51	34	43.2	26	356	.....
20	28.650	54	39	47.3	24	389	0.15
21	28.734	47	31	31.5	24	252	0.30
22	28.957	32	27	30.0	24	188	.....
23	28.897	40	30	36.8	22	214	.....
24	29.150	43	34	36.7	16	181	.....
25	28.656	57	34	51.1	32	389	0.09
26	29.115	58	15	18.6	60	613	.....
27	29.213	36	13	29.0	46	408	.....
28	29.500	34	24	25.7	38	416	.....
29	28.973	36	22	32.7	20	240	.....
30	28.991	34	27	31.2	26	279	.....
Means.	28.996	42.9	27.6	34.5	Sums.	10,547	2.26

Highest barometer, 29.537 inches; lowest, 28.410 inches; highest temperature, 60°; lowest, 2°; maximum velocity of wind, 60 miles; prevailing winds, S., N. W., W.; No. of cloudy days, 10; No. of fair days, 5; No. of clear days, 15; range of thermometer, 58°; range of barometer, 1.127 inches.

Memoranda: No. of times wind blew from the N., 3; E.. 2; S., 36; W., 9; N. E, 1; S. E., 5; S. W., 11; N. W., 23. (Three observations daily.)

METEOROLOGICAL RECORD FOR THE MONTH OF DECEMBER, 1883.

Day.	Mean daily barometer.	Maximum thermometer.	Minimum thermometer.	Mean daily temperature.	Maximum velocity of wind.	Wind, number of miles traveled.	Rainfall.
	Inches.	°	°	°	Miles.		Inch's
1	28.801	49	32	37.1	26	327	.....
2	29.212	35	17	26.8	36	420	.....
3	29.022	36	16	26.5	28	295	.....
4	28.893	42	29	35.8	24	271	.....
5	29.143	43	31	35.1	11	122	.....
6	28.828	51	32	43.7	18	241	0.30
7	28.808	51	28	36.0	30	498	.....
8	29.156	36	24	26.0	22	347	.....
9	29.131	42	25	36.2	16	156	.....
10	29.309	38	29	33.2	28	351	.....
11	29.121	44	29	38.9	29	280	.....
12	29.046	45	28	37.8	28	240	.....
13	28.733	44	36	38.5	30	215	.....
14	29.159	37	12	16.5	32	448	.....
15	29.100	15	9	12.6	22	274	—*
16	28.896	18	5	19.5	24	266	0.11
17	28.536	14	— 3	8.9	24	281	0.35
18	29.082	17	— 5	0.7	22	336	.....
19	29.345	0	—11	— 3.4	10	128	.....
20	29.258	14	— 4	4.1	15	——	0.07
21	29.228	17	0	8.5	18	197	—*
22	29.218	9	1	6.6	22	275	0.07
23	28.748	24	8	22.1	28	380	0.52
24	28.848	25	11	20.0	15	190	.....
25	28.728	27	12	22.3	16	195	.....
26	28.617	34	17	24.1	40	457	0.48
27	29.047	17	1	3.8	40	518	.....
28	28.985	22	— 2	13.9	28	189	.....
29	28.871	24	6	19.4	13	132	.....
30	29.035	25	22	23.9	28	403	0.05
31	29.288	25	16	21.1	16	300	.....
Means.	29.025	29.6	14.6	22.33	Sums.	8934	1.95

Highest barometer, 29.454 in.; lowest, 28.398 in.; highest temperature, 51°; lowest, —11°; maximum velocity of wind, 40 miles; prevailing winds, N., W., S., N. W.; No. of cloudy days, 10; No. of fair days, 10; No. of clear days, 11; range of thermometer, 62°; range of barometer, 1.056 in.

Memoranda. No. times the wind blew from the N., 14; N. E., 6; E., 1; S. E., 6; S., 23; S. W., 10; W., 8; N. W., 24. (Three observations daily.)

* Precipitation too small to be measured.

METEOROLOGICAL SUMMARY FOR THE YEAR 1883.

Month.	Mean monthly barometer.	Mean maximum thermometer.	Mean minimum thermometer.	Mean monthly temperature.	Maximum velocity of wind.	Wind, number miles traveled.	Rainfall.
1883.	Inches.	°	°		Miles.		Inch's
January....	29.043	18.3	—4.6	8.5	25	6,666	1.01
February...	29.169	25.6	7.8	17.0	28	6,112	1.64
March.....	28.995	36.7	19.6	27.1	32	7,606	0.32
April.....	*———	.....	.....	.....	.....	.....	.....
May.....	28.883	63 5	43.7	51.5	.....	.....	6.98
June	28.872	74.5	55.9	65.2	.....	.....	7.57
July	29.928	79.1	60.8	70.2	.....	.....	8.89
August.....	29.027	78.3	59.2	66.1	36	5,458	2.74
September .	29.058	65.8	49.0	56.6	36	6,443	2.39
October.. ..	29.081	52.1	40.6	46.3	48	8,372	3.79
November..	28.996	42.9	27.6	34.5	60	10,547	2.26
December ..	29.009	29.6	14.6	22.3	40	8,934	1.95
Means.....	†29.006	‡51.5°	‡34.1°	†42.3°	Sums.	**60,138	†39·54

Highest barometer,† 29.608 in.; lowest,† 28.332 in.; highest temperature,† 89°; lowest, †—23°; maximum velocity of wind, 60 miles; prevailing winds, N. W., W., S. W., S.; No. of cloudy days,† 108; No. of fair days,† 121; No. of clear days,† 99; range of thermometer,† 112°; range of barometer,† 1.276 in.

Memoranda: No. times† wind blew from the N., 127; E., 46; S., 173; W., 126; N. E., 77; S. E., 95; S. W., 150; N. W., 187. (Three observations daily.)

NOTE — Observations for January, February and March were taken at the U. S. Signal Station, Madison. Observations for April were not taken. Observations from May 1st to May 5th, and From May 11th to July 30th were taken at the North Dormitory, University. Observations from August 2d throughout the remainder of the year were taken at Washburn Observatory.

** For 233 days. ‡ For 321 days.

† For 328 days. * No observations were taken during April.

XVIII. METEOROLOGICAL OBSERVATIONS AT MADISON DURING THE YEARS 1853–1883.

In Vol. I. of the *Publications of the Washburn Observatory,* tables of meteorological observations from 1872-1881, were given which were furnished by the U. S. Signal observer at Madison. The Washburn Observatory has since come into possession of most of the original records of observation and I have thought it proper to give summaries of all the observations which have been made in Madison, and especially at the University. In cases of discrepancy between Vol. I and the present volume, the latter is to be preferred.

The compilation has been done by Mr. G. W. Brown, Meteorological Observer.

The detailed tables are not given here, as I have furnished them for printing in the First Annual Report of the Agricultural Experiment Station of the University.

All the observations have been made thrice daily, at 7 A. M., 2 P. M. and 9 P. M.

From 1853 January, to 1864 June, the data are taken from the manuscript records, (re-reduced in some cases) supplemented by the numbers given in the *Results of Meteorological Observations made under the U. S. Patent Office and Smithsonian Institution from* 1854 *to* 1859 *inclusive,* (Vol. I): from 1869 January, to 1878 October, the data are from the *ms.* records, supplemented by the (printed) annual reports of Prof. W. W. Daniells to the Regents of the University; from 1878 October, to 1883 April, from the *ms.* records of the U. S. Signal Station at Madison; from 1883 April, to 1884, January, from the *ms.* records of observations at the Washburn Observatory.

OBSERVERS AND PLACES OF OBSERVATION.

From 1853 January to 1855 June, the observations were made by Prof. J. H. CARPENTER, at the North Dormitory, University. From 1854 June to 1856 January, they were made by Prof. J. W. STERLING, at the North Dormitory. From 1856 March to 1857 January, the observations were made by Dr. A. SCHUE at (his office on Main street city of Madison?). From 1857 January to 1864 May, they were made by Prof. J. W. STERLING at the North Dormitory and at the Main Building of the University. From 1869 January to 1878 October, they were made by Prof. W. W. DANIELLS, at the latter place. From 1878 October to 1883 April, they were made by Sergeants F. M. M. BEALL and C. A. SHAW, at the U. S. Signal Station, Brown's block, in the city of Madison. From 1883 May to 1883 August, they were made by Mr. J. C. OFFICER, at the North Dormitory. From 1883 August to 1883 December 31, they were made by Mr. JOHN TATLOCK and Mr. G. W. BROWN at the Washburn Observatory.

NOTES ON THE OBSERVATIONS.

Beside the special remarks with the tables, the following general facts should be noted: In all cases where the observations were made for a portion of a month only, the rainfall, the number of days on which snow or rain fell, and the movement of the wind have been omitted from the monthly means and sums. Up to October 1879, the maximum and minimum temperature given, were simply the highest and lowest readings of the thermometer at the regular hours of observation, viz: 7 A. M., 2 P. M. and 9 P. M. After that date they are read from self-recording instruments. Up to October 1876, the maximum velocity of the wind is simply the greatest velocity recorded (estimated) at these three hours. The maximum velocity during May, June, July, 1883, is the greatest velocity recorded by the anemometer, at the hours 7, 2, 9. During the rest of the series, it is the highest velocity of the twenty-four hours, from 2 P. M. to 2 P. M., as read from the anemometer sheets.

SUMMARY OF METEOROLOGICAL OBSERVATIONS FROM 1869 TO 1883, BY YEARS.

N. B.— See remarks at end of the table.

Year.	Mean yearly barometer. (Inches.)	Mean yearly temperature.	Highest temperature of the year.	Lowest temperature of the year.	Range of temperature for the year.	Rain, or melted snow. (Inches.)	Mean relative humidity. Per cent.	No. days on which rain or snow fell	Prevailing wind.	Maximum velocity of wind. (Miles per hour)	Yearly movement of wind. (Miles.)
1869	28.966	42.9	89	—11	100	43.27	79.2	103	N. W.	45	.....
1870	28.920	47.2	98	—13	111	27.83	69.5	93	N. W.	35	.....
1871	28.903	46.1	91	—15	106	29.51	70.7	103	W.	35	.....
1872	28.897	44 4	92	—28	120	22.44	73.9	87	S.W. N. W.	35	.....
1873	28.893	43.8	91	—21	112	26.49	76.5	80	N. W. S. W.	35	
1874	28.950	45.5	96	—15	111	29.02	74.1	85	S. W.	35	....
1875	28.917	42.4	86	—25	111	22.59	74.2	100	W. S. W.	25	....
1876	28.921	46.1	90	—22	112	36.04	78.3	93	N. W. S. W.	35	.....
1877	28.887	47.7	88	—16	104	27.67	77.3	84	S. W.	25	... .
1878	28.721	49.7	92	— 9	101	39.54	71.7	104	N. W.	50	[23132]
1879	28.993	47.9	91	—22	113	35.10	68.7	108	S.	48	87425
1880	28.989	48.1	93	—21	114	46.72	70.0	138	S. W.	50	90855
1881	29.001	46.9	95	—20	115	52.92	72.4	158	N. W. S.	45	84342
1882	29.005	47.1	87	—13	100	42.89	75.3	160	N. W. W.	48	85448
1883	29.006	42.3	89	—23	112	39.54	77.9	121	N. W. S.	60	[60138]
Means .	28.931	45.9	91.0	—19.8	110.8	34.77	74.0	106	N. W. S. W.	50.2	87018

Remarks.— For 1878, the maximum velocity of the wind and the No. of miles traveled were observed for October, November, December, only.

For 1883, the same data are for 233 days only; the maximum and minimum Thermometer and Range of Temperature for 323 days. The other data for 328 days.

The mean Barometer, temperature, rainfall, humidity, No. of days on which snow or rain fell, are given from all the data 1869–1883. The *mean* highest and lowest temperature, the range, and the maximum velocity and number of miles traveled by the wind, relate only to the years 1879–1883.

SUMMARY OF METEOROLOGICAL OBSERVATIONS FROM 1853 TO 1883, BY MONTHS.

Month.	Mean monthly Barometer (inches). 1853–1883.	Mean monthly temperature. 1853–1883.	Mean maximum temperature. 1879–1883.	Mean minimum temperature. 1879–1883.	Mean monthly range of temperature. 1879–1883.	Mean monthly fall of rain or melted snow (inches). 1853-1883.	Mean relative humidity (per cent). 1855–1883.	Mean number of days on which rain or snow fell. 1853-1883.	Mean direction of wind. 1853–1883.	Mean maximum velocity of hour).	Mean monthly movement of the wind (miles.) 1879–1883.
January	28.994	18.4	44.5	—13.4	57.9	1.60	81.6	8.5	S. W.	32.0	7323
February	28.979	22.1	51.6	— 5.8	57.4	1.65	80.7	7.0	N. W.	32.6	7766
March	28.901	31.0	57.8	5.2	52.6	2.04	72.0	7.8	N. W.	37.2	8834
April	28.883	44.5	77.7	17.0	60.7	2.27	66.2	8.4	S. W. S.	40.2	8053
May	28 916	58.0	83.2	36.0	47.2	3.74	64.1	9.8	S. N. E.	33.0	7230
June	28.899	67.2	87.2	46.0	41.2	4.72	69.7	10.0	S. W.	39.0	6186
July	28.960	72.6	90.4	53.2	37.2	4.18	68.3	8.0	S. W.	27.7	5499
August	28.959	70.0	90.0	50.0	40.0	3.17	69.2	8.0	S. N. W.	34.6	5641
September	28.977	61.2	83.8	40.8	43.0	3.35	69.9	8.1	S.	32.8	6408
October	28.973	48.5	77.9	27.7	50.2	3.03	71.2	8.3	S.	38.0	7708
November	28.954	33.7	61.7	8.8	52.9	2.13	77.2	8.2	N. W.	35.7	8312
December	28.992	22.6	46.0	— 9.8	55.8	1.55	80.7	9.0	N. W.	34.8	7880
Means.	28.949	45.8	.....	.....	48.0	2.78	72.6	8.4	.....	34.8	7237
Sums.	.....	.....	.....	.....	.....	33.41	.....	101.1	.....	.....	86836

TIMES OF SUNRISE AND SUNSET AT MADISON FOR EVERY TENTH DAY OF THE YEAR.

NOTE — The times are given in the local time of the 90th meridian from Greenwich. (Central times.)

Day of the year.	Time of sunrise.	Time of sunset.	Day of the year.	Time of sunrise	Time of sunset.
	h. m.	h. m.		h. m.	h. m.
January 1	7 30	4 34	July 1	4 21	7 41
11	7 28	4 45	11	4 28	7 38
21	7 23	4 56	21	4 37	7 31
February 1	7 13	5 10	August 1	4 48	7 20
11	7 1	5 25	11	4 58	7 7
21	6 48	5 37	21	5 10	6 52
March 1	6 35	5 48	September 1	5 22	6 34
11	6 16	6 0	11	5 33	6 16
21	5 58	6 12	21	5 43	5 58
April 1	5 41	6 24	October 1	5 56	5 40
11	5 23	6 35	11	6 7	5 23
21	5 8	6 48	21	6 20	5 6
May 1	4 52	6 59	November 1	6 33	4 51
11	4 39	7 10	11	6 46	4 38
21	4 28	7 20	21	6 58	4 30
June 1	4 20	7 30	December 1	7 10	4 25
11	4 17	7 36	11	7 20	4 24
21	4 17	7 41	21	7 28	4 27

XIX. LIST OF THIRTY-EIGHT AURORAS SEEN AT THE WASHBURN OBSERVATORY, 1881–2–3.

NOTE: The times are Chicago mean times until November 23, 1883, and after that date they are $2^m\ 22^s$ slow of Madison mean time. Those marked with a star are not in the list of Auroras observed at Sauk City.

No. 1. 1881. Dec. 10.* Through a break in the clouds an aurora was seen about 9^h for 10^m. It was 15° high and looked rosy. All cloudy after $9^h\ 30^m$.

2. 1881. Dec. 23. Low auroral arch first seen $6^h\ 30^m$; $10^h\ 35^m$ much fainter. Still a faint arch $12^h\ 30^m$.

3. 1882. Jan. 11. Low auroral arch first seen $8^h\ 27^m$.

4. 1882. Jan. 19. Low auroral arch first seen $6^h\ 30^m$; Double arch about $9^h\ 6^m$. Aurora still present about 12^h.

5. 1882. Jan. 27.* Aurora first seen $6^h\ 32^m$. End $9^h\ 50^m$. Not very bright.

6. Jan. 31.* Dense clouds. At $6^h\ 5^m$ a large rosy patch of Aurora (?) was seen in the N. E. at an altitude of about 10°. At $6^h\ 6^m$ the clouds had covered it. [It is quite possible that this was due to fires of brushwood, as I have seen such cases.]

7. Feb. 5. Auroral arch 10°–12° high. First seen 6 45^m. Disappeared at $7^h\ 45^m$.

8. Feb. 9. Aurora with streamers. First seen $10^h\ 3^m$.

No. 9. April 16. At $9^h\ 24^m$ a fine auroral arch first seen. All white and a simple arch. This continued moving upward, and at $9^h\ 36^m$ included *Polaris*. Between 10^h and 11^h it formed a splendid corona with rays to all parts of the horizon. At $11^h\ 24^m$ it was the brightest and most magnificent display I have ever seen. There was rather less rosy color in it than in displays of the kind which I remember. The telegraph wires between Chicago and New York could not be worked. Between Chicago and St. Paul a few messages were sent by the atmospheric electricity alone.

See *Nature*, May 18, 1882, for an account of the magnetic disturbances. Also — Note on the aurora of April 16–17, by Professor H. C. Lewis, Trans. Amer. Phil. Soc., April 21, 1882.

10. April 20. $8^h\ 20^m$ auroral arch, altitude of 14°, $10^h\ 0^m$ 3 streamers upwards; $10^h\ 5^m$ almost vanished: $10^h\ 50^m$ arch as at $8^h\ 20^m$; $11^h\ 10^m$, 5 bright streamers.

11. May 14.* Faint aurora seen at $12^h\ 30^m$ low down.

12. June 12.* Auroral arch; first seen $11^h\ 14^m$.

13. June 14.* Bright Aurora, first seen behind clouds 11^h.

14. June 15.* Auroral arch; dark segment, streamers; first seen $11^h\ 30^m$.

15. July 16.* Aurora. First seen $9^h\ 50^m$. Streamers $10^h\ 0^m$. Simple arch $10^h\ 15^m$, low arch spreading, both east and west, $11^h\ 20^m$.

16. Aug. 9.* 10^h, no aurora; $11^h\ 35^m$ low arch; 12^h arch was brighter and higher.

17. Aug. 16.* Faint aurora $10^h\ 0^m$, brighter at $11^h\ 30^m$, gone at 12^h.

18. Aug. 21.* Bright aurora, $10^h\ 45^m$. Streamers and some rosy color, 11^h—$11^h\ 30^m$.

19. Sept. 3. Bright aurora with streamers about 9^h.

No. 20. Sept. 11.* Bright aurora first seen $9^h\ 0^m$. Sky clouded later.

21. Oct. 16. Auroral arch first seen $7^h\ 40^m$. Still visible $11^h\ 40^m$.

22. Oct. 30. $6^h\ 30^m$.* Large aurora seen through heavy clouds. Raining.

23. Nov. 13. Bright aurora.

24. 1882. Dec. 15. Aurora $11^h\ 0^m$ to $12^h\ 30^m$.

25. 1883. Feb. 4.* Aurora behind clouds, pretty bright . $12^h\ 30^m$.

26. July 29. Bright auroral arch and streamers 50° high, far in the west and east also, 10^h.

27. July 30. Low auroral arch — no streamers between 9^h and 10^h.

28. July 31. Low arch; streamers at 9^h; low arch at 12^h.

29. Aug. 2.* $11^h\ 15^m$. Noticed streamers *like* Aurora in the W. They radiated from a point N. 30° W. with dark spaces between and covered much of the sky, extending even to the east point opposite. The northern sky had no arch, but was covered with streamers very narrow and close together. The appearance was suspiciously similar in form to stratus clouds; but it looked like Aurora. $11^h\ 40^m$ same; 13^h sky overcast.

30. Aug. 5.* Low arch, first seen $11^h\ 40^m$.

31. Aug. 7. Arch 10° high $9^h\ 0^m$; dark segment. 11^h gone. Hazy sky.

32. Sept. 4. 9^h small but well defined arch. No dark segment. Still there 11^h.

33. Sept. 5.* Faint auroral light in N. horizon. $10^h\ 20^m$. Well defined arch. Dark segment. $12^h\ 15^m$. Brighter.

34. Sept. 16. Brilliant aurora. First seen $7^h\ 17^m$. Streamers up to 45° altitude. Undulatory motion east and west. At $9^h\ 15^m$ it had disappeared except a faint light on horizon.

No. 35. Sept. 25. $9^h\ 40^m$. Bright well defined arch. Dark segment. $12^h\ 15^m$ same.

36. Nov. 1. $7^h\ 30^m$. Brilliant arch in North Horizon. Dark segment. 12^h same.

37. Nov. 2. 7^h. Light in north; but could not distinguish its shape on account of clouds.

38. Dec. 1. $8^h\ 45^m$. Low arch. Dark segment.

XX. LIST OF 608 AURORAS OBSERVED AT SAUK CITY, WISCONSIN, FROM 1859 TO 1884, BY F. G. T. LUEDERS.

"At the request of the Director of the Washburn Observatory, I have extracted from my journal of observations of the Aurora Borealis, which extends from July 1859, to the present time, a series of notes for publication. The observations were made at Sauk City, which is in latitude 43° 15′, and longitude 12° 40′ W. of Washington. In general, the observations were closed at 10 or 11 p. m., but in a great many cases they have been prolonged throughout the night.

The terms "dim," "faint" denote a low intensity in the luminous source, while "high streamers," etc., shows that the Aurora was brilliant. "Low" indicates that the nebulous segment or the luminous arch was only a few degrees above the horizon, while "extensive" is applied to those cases where the arches rose to the height of 20° or more. The frequent occurrence of Polar Lights and Heat Lightning (*Wetterleuchten*) together, has attracted my attention, and I have noted such cases. In the following list I have also included sixty-two luminous appearances which have presented themselves in or near the direction of the magnetic meridian, which could not be certainly identified as Auroras, on account of clouds, etc. These have received no numbers in the list, and in the column of remarks are denoted by A."

F. G. T. LUEDERS.

SAUK CITY, WISCONSIN.
1884, March.

LIST OF AURORAS 1859—1884.

No.	Year—Month.	Day.	Remarks.
	1859		
1	July	10	Average brilliancy.
2	July	11	Average brilliancy.
3	July	18	Beams shooting up beyond Polaris. *Heat-lightning*.
4	August	28	Began 1^h after sunset, and soon after spread over the whole northern and a part of the southern sky. High streamers.
5	September	3	Average brllliancy.
6	September	4	Average brilliancy.
7	September	13	Average brilliancy.
8	September	16	Average brilliancy.
9	September	24	Av rage brilliancy.
10	Septémber	27	Average brilliancy.
11	October	18	After 12^h medium streamers.
12	October	20	Rather faint.
13	October	23	Rather faint.
14	November.....	13	Average brilliancy.
15	December	14	Began 7^h ; at 9^h only a trace left.
	1860.		
16	January	1	Average brilliancy.
17	January	11	Average brilliancy.
18	January	20	Low and faint.
19	February.....	18	Began 9^h. No marked features for 2 hours.
20	March	13	Nothing peculiar in appearance.
21	March	23	A thick, dark grevish haze covers a part of the southern sky and also a part of the northern, down to 3° from the horizon. This haze is in constant motion. When separated into clouds, beams of light are plainly seen.
22	March	26	Greatly extended but faint.
....	March	28	A.
23	March	29	Average brilliancy.
24	April	12	Average brilliancy.
25	April	13	Average b·illiancy. High wind.
26	April	14	Average brilliancy.
27	May	6	Average brilliancy.
28	May	10	High streamers.
29	May	12	Average brilliancy.
30	May	14	Low; but streamers.
....	May	17	A.
31	May	18	Vivid; streamers.
32	July	4	Began 8^h 15^m. Thunder storm in the north. Aurora very extensive. Streamers pass through the zenith. At 11^h faint.
33	July	18	Very active streamers; heat-lightning in the south.

LIST OF AURORAS, 1859–1884.

No.	Year—Month.	Day.	Remarks.
34	July	19	Moderate streamers; heat-lightning in the south.
35	August.....	7	Dim; not much extended.
36	August.....	8	Luminous arches moving up and down, emitting beams at intervals.
37	August.....	9	Average brilliancy. Thunder storm in the north.
38	August	10	Of great extent, but faint.
39	August	12	Vivid beams extending to zenith.
40	August	13	Dim and low.
....	August	14	A.
41	August	16	Low.
42	August	18	Moderate. Heat-lightning S. E.
43	August	21	Moderate.
44	August	23	Aurora in the zenith.
....	August	24	A.
45	August	25	Dim.
46	August	26	Extended but faint.
47	August	27	Aurora in the zenith.
48	August	28	Low.
49	August	29	Low.
50	August	30	Average brilliancy.
51	September	1	Average brilliancy.
52	September	5	Average brilliancy.
53	September	6	Average brilliancy.
54	September	7	Extended, but faint. Thunderstorm, gale and heavy rain, interrupting the observation.
55	September	9	Average brilliancy.
56	September	10	Aurora in the zenith.
57	September	11	Faint.
58	September	12	Average brilliancy.
59	September	16	Average brilliancy.
60	September	17	Aurora in the zenith.
61	September	19	Aurora in the zenith.
63	September	20	Low, but streamers.
63	September	21	Low.
64	September	24	Low.
65	September	25	Low. From August 7 to September 25 there was almost a continuous aurora.
66	October	7	Aurora in the zenith.
67	October	8	High; streamers.
68	October	10	Aurorà in the zenith.
69	October	16	Extended, but faint.
70	December	13	Low and faint.
71	December	15	Average brilliancy.
	1861.		
72	January.....	31	Low.
73	February.....	27	Average brilliancy.
74	February.....	28	Average brilliancy.
75	March.....	9	High; streamers.
76	March.....	13	Low; streamers.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
....	March.....	30	A.
77	April.....	20	Vivid; streamers.
78	May.....	4	Low; moderate streameas.
....	June.....	28	A.
79	August.....	4	Vivid; streamers.
80	August.....	5	Vivid; streamers.
81	August.....	9	Vivid; str· amers.
82	August.....	14	Ver y active; moderately high streamers.
83	August.....	18	Moderate; thunderstorm in S.
84	August.....	22	High streamers.
....	August.....	23	A.
....	August.....	27	A.
85	August.....	28	Aurora in the Zenith.
....	August.....	30	A.
86	September.....	1	Average brilliancy.
87	September.....	2	Active; high streamers.
88	September.....	3	High, but faint.
89	September.....	5	Average brilliancy.
90	September.....	22	Average brilliancy.
91	September.	27	Aurora in the zenith; streamers.
92	September.....	29	After 12^h ; streamers.
93	October.....	2	Vivid; streamers.
94	October.....	7	After 12^h ; streamers.
95	October.....	11	Average brilliancy.
96	December.....	4	Active; high streamers.
97	December.....	18	Average b illiancy.
98	December.....	20	Very brilliant, high; streamers.
	1862.		
99	January.....	21	Average brilliancy.
100	January.....	29	Rather faint.
101	February.....	28	Vivid; high streamers.
102	March.....	30	Average brilliancy.
103	April.....	2	After 12^h.
....	April.....	3	A.
104	April.....	13	Average brilliancy.
105	April.....	21	Average brilliancy.
106	April.....	27	Very brilliant; strong streamers.
....	May-.....	4	A.
107	May.....	13	Average brilliancy.
108	May.....	19	Rather dim.
109	June.....	1	Extended; but few streamers.
110	June.....	12	High arches; the streamers do nót persist long. Thunderstorm in S. W.
....	June.....	17	A.
....	June.....	25	A.
....	June.....	26	A.
111	June.....	28	9 P. M. A dark grey haze covers the zenith and the upper part of the N. sky. After half an hour the nebulous body moves northwards, forming a segment which touches the horiz ·n in N. W. and E. N. E. A streaming and whirling commences which lasts for 2^h and fades away.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
112	June	30	Phenomenon similar to June 28th, but far inferior in intensity.
113	July	2	Strong streamers.
114	July.....	5	High; streamers.
115	July	6	High; streamers.
116	July	7	High; streamers.
117	July	9	Average brilliancy.
118	July	20	Appeared in E. which is unusual. Heat lightning in N. W.
119	July	24	Low and faint.
....	July	26	A.
120	July	29	Not low, but faint.
121	August	3	Moderate streamers. Thunderstorm in N. W.
122	August	4	Same. Thunderstorm in S. W.
123	August	8	Nearly the same, Thunderstorm in S. W. and S.
124	August	18	Average brilliancy.
125	August	19	Extended; isolated beams.
126	August	23	Average brilliancy.
127	August	28	Same; heat lightning in N. W.
128	August	31	High streamers; thunderstorm above the horizon in south. Heat lightning above the horizon in N. E.
129	September	1	High streamers.
130	September	3	Average brilliancy.
131	September	25	Began an hour after sunset and lasted throughout the night till sunrise.
132	September	26	Average brilliancy.
133	September	27	Average brilliancy.
134	October	4	Same.
135	October	6	Same. Thunderstorm in S.
136	October	11	Faint.
137	October	21	Faint; strong gale.
138	October	22	High; streamers.
....	November	20	A.
139	December.....	24	Vivid; streamers.
	1863.		
140	January	8	Low; streamers.
141	January	10	High; streamers.
142	January	24	Average brilliancy.
143	February.....	22	Average brilliancy.
....	March	10	A.
144	March	21	Average brilliancy. A thunderstorm next morning.
145	April	8	Faint and low.
146	April	12	Average brilliancy.
147	April	15	Same.
148	April	17	Same.
149	April	18	Same.
....	April	21	A.
....	May	21	A.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
150	June.....	13	Moderate streamers.
151	July	6	Vivid; high streamers.
152	July	23	Average brilliancy.
153	July	26	Same.
154	July	31	Active streamers.
155	August	7	Began 9^h 15^m lasted 30 .
156	August	14	Streamers. Heat-lightning in N. E. Thunder storm in S. W.
157	September	9	High: extended; streamers.
158	September	13	2 A. M. Average brilliancy.
159	September	23	Very extended. The nebulous segment parts into several sub-phenomena; each of which streams towards its own point of convergence.
160	October	9	Rather dim.
161	October	10	Moderate.
162	October	12	Moderate.
163	October	14	Low and faint.
....	October	20	A.
164	November.....	2	Low and faint.
165	November.....	4	Thunderstorm till 8 P. M. after the clouds disperse, aurora.
166	November.....	8	Moderate.
167	December	1	Moderate.
	1864.		
168	February.....	1	Moderate.
169	February.....	8	Moderate.
170	February.....	9	Moderate.
171	May	2	Faint.
172	August	24	Moderate; Heat-lightning S., S. W.
173	August	25	Same: same.
....	August	30	A.
174	September	20	Dim.
175	September	24	Low; streamers.
176	October	6	Moderate.
177	October	8	Moderate.
178	October	9	After 12^h ; moderate.
179	October	20	Average brilliancy.
180	November.....	3	Moderate.
181	November.....	19	Low and faint.
	1865.		
182	January	17	Low and faint.
....	January	18	A.
183	January	29	Same.
184	February.....	18	Low and rather dim.
185	February.....	22	Same.
186	February	23	High streamers.
....	February	26	A.
187	March	16	Low and faint.
188	March	24	Same.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
189	April.	16	Moderately high.
190	May	11	Very extended; active streamers up to the zenith.
191	May	16	After 12^h moderate.
192	May	25	Rather faint.
193	May	26	A few isolated beams.
194	June.....	10	Vivid; high streamers.
195	June.....	23	Moderate; Heat-lightning S. W.
196	July	13	Active.
197	July	16	Moderate.
198	July	17	Faint.
199	July	18	In the zenith.
200	July	22	Vivid; high strcamers.
....	July	23	A.
201	August	4	High; extended; bright arches and isolated clouds, the latter emitting streamers. At 10 P. M. a breeze sprung up from the E. N. E., forcing the streaming clouds towards the west, but leaving the arches undisturbed. The higher arches passed through *Cassiopæa*. Before the wind arose, streamers were seen south of the zenith.
202	August	10	Rather dim.
203	August	11	Faint; soon disappears.
204	August	12	High streamers.
205	August	14	Moderate.
206	August	18	High, extensive and active streamers.
207	August	20	Low; soon disappears.
....	August	21	A.
208	August	25	After 12 ; moderate.
209	August	26	After 12^h.
210	September	8	High; streamers; heat-lightning in N. E.
211	September	10	Moderate.
212	September	11	Rather faint.
213	September	12	Moderate; heat-lightning in N. E.
214	September	20	High; streamers; heat-lightning (once) in N. E.
....	September	28	A.
215	October.....	9	High, but faint.
216	October.....	10	Dim.
217	October.....	15	Faint; all night.
218	October.....	18	High, strong beams.
219	October.....	20	Moderate.
220	November.....	8	Low; active streamers.
221	November.....	11	Low and dim.
	1866.		
222	January.....	8	Dim.
223	January.....	20	Moderate.
224	February.....	1	Rather faint.
225	February.....	5	Moderate.

LIST OF AURORAS, 1859–1884.

No.	Year—Month.	Day.	Remarks.
226	March	5	Dim.
227	March	7	Moderate.
228	March	9	Low; h gh streamers.
229	March	16	Low; and faint.
230	March	18	Low; streamers.
231	May	12	Average brilliancy.
232	May	14	In the zenith.
....	July.....	7	A.
233	July.....	12	Low; streamers.
234	July.....	31	Average brilliancy.
235	August	9	Moderate. Thunder storm above horizon from W. to E.
236	August	15	Moderate.
....	September	11	A.
237	September	12	Moderate.
238	October	5	Low and dim.
....	October	7	A.
239	October	13	Moderate; streamers.
....	October	24	A.
	1867.		
240	March	5	Rather dim.
241	March	7	Average brilliancy.
242	May	2	Low.
243	May	4	Moderate.
244	May	29	High; streamers.
245	June.....	22	Moderate; heat lightning in S.
246	July.....	18	Moderate; unusual position in the west.
....	July.....	19	A.
247	July...	21	Moderate.
248	July.....	22	Dim.
249	July...	28	Moderate.
250	July.....	29	Same.
....	August	5	A.
....	August	10	A.
251	August	13	Moderate.
252	August	14	Same.
253	August	19	Low and dim.
254	August	23	Moderate. Heat lightning in S. S. E.
255	September	1	Moderate.
256	September	6	Faint.
257	September	9	Rather faint.
258	September	13	Strong; streamers.
259	September	16	Moderate; heat lightning below N.W. horizon.
260	September	20	High; streamers.
261	September	21	Moderate.
262	September	22	Low; high streamers.
263	September	25	Very active; streamers.
264	September	26	High; high streamers.
265	September	29	Very extended; dim.
....	October	1	A.
....	October	2	A.

LIST OF AURORAS, 1859-1884.

No.	Year — Month.	Day.	Remarks.
266	October	3	Intense streamers: Thunder storm in W.
267	October	23	Rather dim.
268	November	25	Faint.
	1868.		
269	January	12	Rather faint.
270	January	18	Low; and faint.
271	February	20	Same.
272	March	20	Some streamers.
273	April	12	Situated unusually far to the West.
....	April	15	A.
....	April	18	A.
274	April	19	Somewhat extended.
275	April	20	Low; high streamers.
276	April	27	Extended but faint.
277	May	9	Average brilliancy.
278	May	10	Same.
279	May	18	Same.
280	May	20	Same.
281	May	25	Same. Heat lightning in W.
282	May	30	Of short duration.
283	June	5	Moderate. Heat lightning in N. E.
284	June	10	Very extensive. Covers part of the southern sky. Streamers on both sides of the zenith.
285	June	18	High streamers. Heat lightning below horizon S. S. E.
286	June	20	In zenith.
287	June	29	Low: with high streamers.
288	July	1	In zenith.
289	July	4	Average brilliancy: Heat lightning in S. S. E.
290	July	7	In zenith.
291	July	8	The centre exactly in the zenith.
292	July	10	Very extended: active streamers.
293	July	11	Moderate: Heat lightning in S. S. W.
294	July	13	Streamers: Heat lightning above N. E. horizon.
295	July	14	Vivid and active streamers. A thunder storm in the afternoon.
296	July	16	Low: Heat lightning in W.
297	July	17	Streamers: Same.
298	July	18	Average brilliancy: Heat lightning in S. E.
299	August	9	Low; 4°–5° above horizon. Streamers pass beyond zenith.
300	August	11	Low; high streamers
301	August	13	Low.
302	August	18	Low; streamers.
303	August	20	Low.
304	August	31	Very extended; active streamers.
305	September	3	Low and faint.
306	September	6	Average brilliancy.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
307	September	12	Unusually far east,
308	September	15	Widely extended; consisting of detached clouds from which streamers rise.
309	September	18	Active streamers.
310	September	20	Average brilliancy.
311	September	22	Same.
312	September	23	Same.
313	September	30	Dim.
314	October	14	Low.
315	October	16	Bright; no streamers.
316	October	22	Average; with streamers.
317	November.....	12	Low and faint.
....	November.....	22	A.
318	December	10	Average brilliancy.
319	December	17	Same.
	1869.		
320	January	6	Same.
321	January	7	Rather faint,
322	January	23	Same.
323	February.....	3	Very high; active streamers.
324	February.....	11	Dim.
325	March	2	Rather faint.
326	March	10	Low; streamers.
327	March	17	High; same.
328	March	23	Low and faint.
329	April	2	Very extended; streamers.
330	April	3	Low and streamers.
331	April	4	Same.
332	April	5	Extended; active streamers.
333	April	7	Low.
334	April	9	Low and faint.
335	April	10	Same.
....	April	12	A.
336	April	16	Very extended streamers beyond the zenith.
337	April	30	In the zenith.
338	May	5	Same.
339	May	7	High streamers.
340	May	8	Average brilliancy.
341	May	9	Same; heat-lightning in W.
342	May	10	In the zenith.
343	June.....	1	Average brilliancy.
344	June.....	3	Same.
345	June	4	Same.
346	June	7	Same.
347	September	27	Very vivid; high streamers.
348	September	28	Average brilliancy.
349	September	29	Same.
350	October	25	Same.
351	October	31	High streamers.
352	December	4	High arch; moderate streamers.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
	1870.		
353	January	3	Average brilliancy.
354	January	4	Same; rather far E.
355	January	26	Low and faint.
356	January	31	Same.
357	February	3	Faint.
358	February	11	Average brilliancy.
359	February	20	Low; active streamers.
360	February	24	Average brilliancy.
361	March	1	Same; streamers.
362	March	2	Faint.
363	March	3	Moderate streamers.
364	March	13	Rather faint.
....	March	21	A.
365	March	28	Rather faint.
366	April	2	Same.
367	April	5	High streamers.
368	April	20	Average brilliancy.
369	April	21	Same.
370	April	25	Same.
371	May	1	Same.
372	May	19	Extends over whole northern sky; streamers in isolated groups.
373	June	15	Very active streamers.
374	June	17	Low; high streamers.
375	June	19	Same.
376	June	20	Moderate streamers.
377	June	21	Faint.
378	June	26	Average brilliancy.
379	July	27	High; active streamers. Heat lightning in E. to S.
380	August	19	Extended; active streamers.
381	August	21	Rather faint.
382	August	25	Average brilliancy.
....	August	26	A.
....	August	29	A.
383	September	3	Extended but faint.
384	September	17	Low; active streamers.
385	September	18	Average brilliancy.
386	September	20	Same.
387	September	21	Same; in easterly position.
388	September	25	Average brilliancy.
389	September	26	In zenith.
390	October	14	Very high; thunderstorm in N.
391	October	20	Average brilliancy.
392	October	27	Same; but extending to both sides of the zenith.
393	November.....	12	$8^h\ 15^m$. A dark grey haze covering the zenith. After half an hour the nebulous body moves north, forming an arch emitting streamers.
394	November.....	14	In the zenith. Streamers plainly seen.
395	November.....	17	Dim.
396	November..	21	Dim.

LIST OF AURORAS, 1859–1884.

No.	Year—Month.	Day.	Remarks.
397	November.....	24	High; streamers.
398	December	3	Faint.
399	December	15	Much extended; high streamers.
400	December	21	Average brilliancy.
401	December	22	Low and faint.
402	December	24	Same.
....	December	26	A.
	1871.		
403	January	20	Extended over whole north sky.
404	January	21	Rather faint.
....	January	24	A.
405	February.....	10	Average streamers.
406	February..... ..	13	Same.
407	February.....	21	Same.
408	February.....	24	Very vivid; active streamers.
409	March	21	Average brilliancy.
410	March	28	Same.
411	April	1	Same.
412	April	9	Active streamers.
413	April	11	High streamers.
414	April	13	Same.
415	May	7	Dim.
416	May	8	Average brilliancy.
417	May	19	High streamers. Heat lightning in N. E.
....	May	18	A.
418	May	21	Moderate streamers.
419	May	22	High streamers.
420	June	6	Same.
421	June	10	Very extended and active streamers.
422	June	15	Dim.
423	June	17	Extended; moderate streamers.
424	July	2	Vivid; high streamers.
425	July	14	Average brilliancy.
426	July	21	Same.
427	July	23	Same.
428	August	5	Same. Heat lightning in north.
429	August	11	Moderate.
430	August	12	Faint.
431	August	17	Moderate.
432	August	23	Same.
433	September	6	Low and faint.
434	September	7	Very extended; moderate streamers.
435	October	10	Average brilliancy.
436	November	1	Faint.
437	November	10	Same.
438	November	14	Same.
439	December.....	8	Extended; active streamers.
....	December.....	9	A.
440	December.....	10	In zenith; streamers.
....	December.....	16	A.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks,
	1872.		
441	February	4	Average brilliancy.
442	February	5	Same.
....	March	5	A.
443	March	20	Active streamers.
444	March	28	Average brilliancy.
445	April	3	Same.
446	April	10	Near the zenith; streamers shooting up from detached clouds.
....	April	27	A.
447	May	24	High streamers.
448	May	30	Rather faint.
449	June.....	15	Average brilliancy.
450	June.....	22	Rather faint.
451	July	27	Average brilliancy.
452	August	3	Very high; extending over part of the S. sky.
453	August	8	Moderate: thunder storm in the N.W. horizon.
454	August	14	At 9 P. M. the northern sky presented a very shining aspect, with nothing visible which could explain the source of the illumination.
455	August	20	Aurora in zenith; heat lightning in N.
456	August	24	High; streamers.
457	August	25	Same; heat lightning in S. E.
458	August	26	Same; same in E. S. E.
459	August	29	Low with high streamers.
460	September	4	High; with streamers.
461	September	5	Same; heat lightning in S. E.
462	September	29	Average brilliancy.
463	October.....	14	In the zenith.
464	October.....	16	Average brilliancy.
465	October.....	28	Low; with streamers which originate below (or at) the horizon and extend high.
466	November	23	Low and faint.
467	November	27	Average brilliancy.
	1873.		
....	January	5	A.
468	January.....	18	High; active streamers.
469	January...	25	Average brilliancy.
470	February.....	1	Same.
471	February.....	4	Faint.
472	February.....	21	Low and faint.
473	February.....	23	Low; high streamers.
474	February.....	24	Average brilliancy.
475	March	3	Dim.
476	March	21	Moderately extended; streamers.
477	March	23	Average brilliancy.
478	March	29	Rather faint.
479	April	18	Faint.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
480	April.....	21	Faint.
481	May	15	Average brilliancy.
482	May	16	Dim.
483	May	23	Average brilliancy.
484	May	28	Same.
485	June...	1	Intense; with streamers.
486	June.....	11	Dim.
487	June.....	18	Extended but faint.
488	June.....	20	Faint.
489	June.....	23	Average brilliancy. Heat lightning in W. and N.
490	June	24	Average brilliancy.
491	June.....	26	Extended; active streamers.
492	June.....	27	High; same.
493	July	16	Rather faint.
494	July	21	Low; active streamers.
495	July	30	Faint.
496	August	12	Average brilliancy.
497	August	17	Same; thunderstorm low in S.
498	August	18	Low.
499	August	26	Average brillancy; after 12^h.
500	August	27	Low; high streamers.
501	September	13	Average brilliancy.
502	September	22	Rather dim.
503	December	14	Average brilliancy.
	1874.		
504	February.....	14	Same.
505	March	7	Extended but rather faint.
506	March	8	Average brilliancy.
507	April	3	Low.
508	April	6	Average brilliancy.
509	April	7	High; with streamers.
510	May	4	Vivid; same.
511	June.....	3	High; with streamers.
512	July	12	Low; moderate streamers.
513	August	12	High; streamers.
514	September	11	Faint; heat lightning in W. N. W.
515	October	3	Extended; high streamers.
516	October	4	Average brilliancy.
517	October	6	Average brilliancy.
518	October	13	Average brilliancy.
519	November.....	7	Average brilliancy.
520	November.....	28	High; streamers.
521	November.....	29	Low and faint.
	1875.		
522	February.....	24	Dim.
523	February.....	26	Extended and active streamers.
524	March	2	Average brilliancy.
525	April	7	Same.
....	May	2	A.
526	July	26	Rather faint.
527	July	30	Same.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
....	September	3	A.
528	September	7	Over the whole N. sky.
....	September	8	A.
529	October	31	Average brilliancy.
	1876.		
530	January	14	Low.
531	January	27	Low.
532	February	13	Average brilliancy.
533	February	17	Extended but faint.
534	February	19	Same; active streamers.
535	March	25	Faint.
536	March	26	Same.
537	July	16	Average brilliancy; streamers.
538	August	11	Low; high streamers.
539	August	12	Average brilliancy.
540	September	22	Very bright; no streamers seen.
541	November	10	Dim.
542	November	14	Dim.
543	December	7	Dim.
	1877.		
544	January	7	Low aud dim.
545	March	9	Extended; active streamers.
546	April	5	Faint.
547	April	14	High; streamers.
548	May	2	Same.
549	May	28	Same.
....	June	19	A.
550	October	11	Extended but faint.
551	November.....	9	Average brilliancy.
..	December.....	6	A.
	1878.		No aurora was seen by the observer during 1878 within usual hours of observation.
	1879.		
552	April	19	High; streamers.
553	June.....	17	Same.
554	September	10	Low and faint.
555	October.....	8	Same.
	1880.		
556	February.....	15	Dim.
557	March	12	High; streamers.
558	April	1	Moderate streamers.
....	April	9	A.
559	May	1	Average brilliancy.
560	May	14	Same.
561	August	5	Rather faint.
562	August	12	High; streamers.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
563	August	13	High streamers; heat-lightning in N.E.
564	August	27	Same. Thunder storm on the previous afternoon.
565	August	31	Average brilliancy; heat lightning in E. and S. E.
566	September	27	High; streamers.
567	October.	7	Average brilliancy.
	1881.		
568	March	18	Same; streamers.
569	April	28	High; streamers; thunder storm in day.
570	September	12	Average brilliancy.
....	September	13	A.
571	November...	8	Very active streamers still visible in morning of November 9th.
572	November.....	19	Average brilliancy.
573	November.....	23	Extended but faint.
574	December.....	8	Average brilliancy.
575	December.....	9	Rather dim.
576	December	14	Extended; high streamers,
577	December	23	Average brilliancy.
	1882.		
578	January.....	11	Low: high streamers.
579	January.....	19	Extended; moderate streamers.
....	February.....	1	A.
580	February.....	5	Low; few streamers.
581	February.....	9	Same.
582	February.....	12	Same.
583	February.....	13	Aurora in the zenith, concealed by a dark haze. In N. E. and S.W. where the clouds are divided, streamers are seen.
584	April	15	Rather faint.
585	April	16	Extended; active streamers.
586	April	20	Average brilliancy.
587	August	10	Moderate streamers.
588	September	3	Low, and at long intervals a few streamers.
589	October.....	14	Low; streamers.
590	October	16	Low and faint.
591	November.....	13	Low; a few streamers.
....	November.....	15	A.
592	November.....	18	Extended; moderate streamers.
593	November.....	19	Moderate streamers,
594	December.....	15	Extended; same.
	1883.		
595	February.....	27	Moderate streamers.
....	February.....	28	A.
....	March	2	A.

LIST OF AURORAS, 1859–1884.

No.	Year — Month.	Day.	Remarks.
596	March	28	Average brilliancy.
597	April	15	Same.
598	April	24	Same.
599	July	29	Rather faint.
....	July	30	A.
600	July	31	Dim,
601	August	4	In the zenith; occasionally streamers are seen.
602	August	7	Rather faint.
603	September	4	Faint.
604	September	16	Very extended; active streamers.
605	September	25	Low; high streamers.
606	November	1	Average brilliancy.
607	November.....	2	Same.
608	December.....	1	Same."

The following summary of Mr. LUEDER's observations may be found useful. It refers *only* to this series, and does not include the auroras observed at Madison.

NUMBER OF AURORAS IN THE YEARS 1859—1884.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Sums.
1859	.....	.....	.....	.....	.....	.....	3	1	6	3	1	1	15
1860	3	1	4	3	5	0	3	16	15	4	0	2	56
1861	1	2	2	1	1	0	0	7	7	3	0	3	27
1862	2	1	1	4	2	4	8	8	5	5	0	1	41
1863	3	1	1	5	0	1	4	2	3	4	3	1	28
1864	0	3	0	0	1	0	0	2	2	4	2	0	14
1865	2	3	2	1	4	2	5	9	5	5	2	0	40
1866	2	2	5	0	2	0	2	2	1	2	0	0	18
1867	0	0	2	0	3	1	5	4	11	2	1	0	29
1868	2	1	1	4	6	5	11	6	9	3	1	2	51
1869	3	2	4	9	5	4	0	0	3	2	0	1	33
1870	4	4	5	5	2	6	1	3	7	3	5	5	50
1871	2	4	2	4	5	4	4	5	2	1	3	2	38
1872	0	2	2	2	2	2	1	8	3	3	2	0	27
1873	2	5	4	2	4	8	3	5	2	0	0	1	36
1874	0	1	2	3	1	1	1	1	1	4	3	0	18
1875	0	2	1	1	0	0	2	0	1	1	0	0	8
1876	2	3	2	0	0	0	1	2	1	0	2	1	14
1877	1	0	1	2	2	0	0	0	0	1	1	0	8
1878	0	0	0	0	0	0	0	0	0	0	0	0	0
1879	0	0	0	1	0	1	0	0	1	1	0	0	4
1880	0	1	1	1	2	0	0	5	1	1	0	0	12
1881	0	0	1	1	0	0	0	0	1	0	3	4	10
1882	2	4	0	3	0	0	0	1	1	2	3	1	17
1883	0	1	1	2	0	0	2	2	3	0	2	1	14
Sums...	31	43	44	54	47	39	56	89	91	54	34	26	608

ERRATA AND ADDITIONS TO VOL. I.

Page 8. The longitude of the 6-inch Equatorial is $+0^h\ 49^m\ 25^s.60$.

84. No. 35. R. A. for $19^h\ 17^m\ 1^s$, read $19^h\ 16^m\ 52^s$. Dec. for $-18°$ 43′, read $-18°\ 44'$. For 1781.638, read 1881.638.

86. No. 42. For Anon, read Aoe, 20926. Dec. For $-17°\ 44'$, read $-17°\ 46'$.

161. VIII. Title, *dele* the word "Reduce."

161. Line 9 from top: R. A. for $1^h\ 58^m\ 45^s$, read $1^h\ 48^m\ 45^s$.

168. The position of the Lick Observatory from Coast Survey data, kindly communicated by PROF. DAVIDSON, is,

Latitude $= +37°\ 20'\ 23''.5$.

Longitude $= 8^h\ 6^m\ 34^s.15$ (Greenwich.)

Longitude $= 2^h\ 58^m\ 22^s.06$ (Washington.)

ERRATA AND ADDITIONS TO VOL. II.

Page 2, line 10; for A read An.

35, line 20; for ± 0.005 read ± 0.0005.

35, line 25; for + 0.00045 read + 0.0045.

35, from measures of the distances of the wires of the glass reticle (May 1884) the value of the R. A. screw is $4^s.271 \pm 0.0015$. The adopted value of the screw, from both series is $4^s.283$.

41, diameter of pivots; for 1.333 read 1.339.

NOTE TO PAGE 72.

During the period July 9–Aug. 22 the North Collimator micrometer was used to set on the fixed wires of the S. C. which remained untouched. The N. C. itself was unchanged, except as to its micrometer. The variations in the micrometer reading for the coincidence of the collimators show then the sum of the variations in the collimation of the N. C. and S. C. and of any variations in the relative positions of the Ys of the two collimators, due either to bodily movement of the brick piers or to shifts in the position of their adjusting screws. The table gives the reading for coincidence for each day. During the period July 9–13 to July 24–28 the total angular change was 4″.97. Supposing the S. C. to remain absolutely fixed and the whole change to be in the brick pier of the N. C. it would follow that the change of this pier was less than 0.005 inches to the *East*. From July 24–28

to Aug. 6–9 the whole change was 3″.64. Under the same suppositions, the brick pier of the N. C. moved less than 0.004 inches to the *West.* From Aug. 5–9 to Aug. 19–22, the whole change was 1″.61. Under the same suppositions, the brick pier of the N. C. moved less than 0.002 inches to the *East.* It appears to me that these figures show a remarkable stability in the piers, in the collimator micrometers and in the mountings of the Ys of the collimators themselves. Even when the sum of all the possible changes is thrown upon the change of the brick pier of the N. C. alone, the mean daily movement of this pier (using all the observations) is not above 0.001 inches in the direstion East—West. The variations in level are much greater.

Date.	Rev.	Date.	Rev.	Date.	Rev.	Date.	Rev.
1883.		1883.		1883.		1883.	
July 9..	.828	July 24..	.732	Aug. 8...	.760	Aug. 28...	.....
10..	.816	25..	.723	9...	.756	Setting of S. C. changed.	.....
11..	.798	26..	.724	10...	.752	Aug. 23...	.097
12..	.758	27..	.707	11...	.740	24...	.102
13..	.765	28..	.722	12...	.751	25...	.105
14..	.776	29..	.720	13...	.751	26...	.106
15..	.755	30..	.734	14...	.778	27...	.119
16..	.742	31..	.733	15...	.708	28...	.108
16..	.735	Aug. 1..	.732	16...	.753	29...	.109
17..	.740	2..	.728	17...	.755	30...	.198
18..	.795	3..	.710	18...	.755	31...	.097
19..	.800	3..	.777	19...	.757	Sept. 3...	.097
20..	.801	4..	.780	20...	.754	.....	.....
21..	.746	5..	.778	21...	.748	.....	.....
22..	.727	6..	.820	21...	.749	.....	.....
23..	.730	7..	.757	22...	.757	.....	.....

Page 76, line 22; for N. C. read U. C.
83, line 12; for C–D read D–C.
85, line 23; for single read nine.
98, No. 101, column Remarks, dele ?
99, No. 108, column Name; dele ?

Page 99, No. 108, column R. A.; for 16^s read 15^s.
99, No. 108, column Dec; for 57′ read 58′.
110, No. 7, for 17728 read 17704.
110, No. 9, for 48^s.10 read 48^s.5,
111, No. 18, add Time $\pm$ 0^s.3.
111, No. 22, for 52^s.49 read 52^s.62,
116, No. 37, for —12° 23′ read +12° 23′.
121, No. 175, for 13.3 rəad 31.3.
124, No. 250, for 5.6 read 5—6.
124, No. 270, for Struve's read strong.
127, No. 342, for —8 15 read —8 51.
128, No. 377, for gazing read gaging.
134, No. 515, for 48 35 read 43 35.
135, No. 542, for +28 44 read +29 24.
135, No. 553, for +11 34 read +17 34.
136, No. 593, for 47.0 read 17.4.

Page.	Line.	Col.	For	Read
144	5	Sweep.	353	358
144	8	Remarks.	Same.	Some.
145	6	Sweep.	332	362
145	11	R. A.	26	36
145	14	R. A.	33	53
145	14	N. P. D.	27	37
145	15	N. P. D.	37° 21′	101° 37′
145	15	No. Stars.	21	21.1
145	27	R. A.	3	8
146	11	R. A.	13	18
147	3	N. P. D.	103	108
148	19	N. P. D.	19	49
148	21	N. P. D.	36	56
150	9	R. A.	29	39
150	13	N. P. D.	50	56
150	14	N. P. D.	38	39
150	17	R. A.	10	16
152	27	R. A.	32	28
153	20	R. A.	28	23
153	29	N. P. D.	37	39
154	29	No. Gauges.	$\frac{1}{2}$	$\frac{1}{8}$
155	8	R. A.	25	28
156	11	Sweep.	716	715
156	17	No. Stars.	2.3	20.3
156	21	Sweep.	815	816

Page 164, No. 827; for $7^h\ 52^m\ 1^s$, read $7^h\ 2^m\ 1$.
188, No. 296; for 60 read 69.
261, Table; for $23^h\ 40^m$ read $23^h\ 20^m$.
262, Table; for $15^h\ 30^m$ read $15^h\ 20^m$.
263, Table; for $8^h\ 30^m$ read $8^h\ 20^m$.
263, Table; under $13^h\ 0^s$; $+3°$, read 3.054.
264, Table; interchange $21^h\ 20^m$ and $21^h\ 30^m$.
269, Table; line 2, supply "R." and "for."

APPENDIX

Catalogue of the Woodman Astronomical Library

OF THE

WASHBURN OBSERVATORY

UNIVERSITY OF WISCONSIN.

PART I.—TO JUNE 1, 1884.

TRUSTEES OF THE WOODMAN ASTRONOMICAL LIBRARY FUND.

HON. ORSAMUS COLE,

CHIEF JUSTICE OF THE SUPREME COURT OF WISCONSIN.

HON. WILLIAM F. VILAS,

REGENT OF THE UNIVERSITY OF WISCONSIN.

PROF. EDWARD S. HOLDEN,

DIRECTOR OF THE WASHBURN OBSERVATORY.

INTRODUCTORY NOTE.

The books in the library come from the following sources:

(*a*) From the professional library of Professor JAMES C. WATSON; these were bequeathed by him to the National Academy of Sciences, and are loaned by the Academy to the Washburn Observatory;

(*b*) From books purchased from funds given by Governor C. C. WASHBURN; this category comprises nearly all books bought before 1883;

(*c*) From books purchased during 1883 from a specific gift of Hon. CYRUS WOODMAN;

(*d*) From books bought from a permanent fund provided for the support of the library by Mr. WOODMAN;

(*e*) From gifts to the Washburn Observatory from scientific societies, from observatories, and from astronomers at home and abroad.

The following pages contain a catalogue of the books and pamphlets in the library at the date of printing. The catalogue is arranged alphabetically by authors, except that for convenience, the title word for observatories, scientific societies and government departments, is taken as the city in which the observatory, society, etc., has its permanent home. Complete volumes issued by an observatory, are usually credited to the observatory and not to the author.

Extracts from observatory publications are, however, credited to the author, and so in similar cases. In so small a library as this, no attempt at bibliographic accuracy is required. The *format* of books as 4to, 8vo, etc., as here given relates rather to their size. For exact information the catalogue of the great astronomical library at Pulkova should be consulted; when such work is once done in a perfect manner, it need not be continually repeated.

One word may be said of the arrangement of the books and pamphlets in the library. While the catalogue is arranged by authors only, the books are arranged on the

shelves by subjects. The pamphlets are kept in large drawers immediately below the book shelves, and a drawer is devoted to a subject. As soon as a pamphlet is received it is catalogued under its author's name, and placed in the drawer devoted to its subject. All the pamphlets on a given subject can therefore be at once consulted in one place; and all the works of a given author are to be found together in the card catalogue. I have used this plan for keeping pamphlets for eleven years, in my own library, in the library of the United States Naval Observatory, and here, and I consider it to be an entirely satisfactory solution of the troublesome problem of how to treat pamphlets in professional libraries. I give below a list of the subjects which have been adopted. These titles are printed in large letters on the front of each drawer.

Mathematics, Mathematical Tables; Catalogues of Stars, Ephemerides; Astronomical Tables; Geodesy in General; Geography; Terrestrial Physics; Geographical Positions; The Sun, Solar Eclipses, Solar Parallax; The Moon, Occultations; Theoretical Astronomy, Methods; Planets, Transits of Inferior Planets; Fixed Stars, in General; New and Variable Stars, Double and Binary Stars; Astronomical Constants, Precession, Aberration, Nutation, Obliquity, Refraction, etc.; Proper Motions of Stars, Stellar Parallax; Nebulae and Clusters; Observatories, Reports of (Descriptions); Astronomical Instruments, Price Lists, (Descriptions); Comets, Meteors, Zodiacal Light; Optics, Photometry; Meteorology, in General; Astronomical Biography; Astronomical Bibliography; Publisher's Book Lists; Time-Services, etc.; Star-Charts and Atlases.

I shall be glad if those to whom this volume is sent will turn to the pages in the following catalogue which give the works written by them, and see if it is in their power to supply the missing volumes of our collection. Any such contributions will be very gratefully received. They may be sent through the Smithsonian Institution, Washington, free of expense, and should be addressed to the Library of the Washburn Observatory, Madison, Wisconsin.

EDWARD S. HOLDEN.

CATALOGUE OF THE LIBRARY.

ABBE (C.): The Portable Transit instrument in the vertical of the Pole Star (translated from W. DOELLEN). Washington, 1870. 8vo.

———: Historical Note on Least Squares. New Haven, 1871. 8vo.

———: Auroras 1776–1784, in Labrador. New Haven, 1873. 8vo.

———: Report on the Solar Eclipse of July, 1878. Washington, 1881. 4to.

ADAMS (J. C.): Note on the value of EULER'S Constant, etc. London, 1877. 8vo.

———: On the expression of the product of any two LEGENDRE'S coefficients by a series of LEGENDRE'S coefficients. London, 1877, 8vo.

———: On the motion of the Moon's Node, etc. London, 1877. 8vo.

———: Note on a remarkable property of the analytical expression for the constant term in the reciprocal of the Moon's Radius Vector. London, 1878. 8vo.

———: Continuation of * * * DAMOISEAU'S Tables of Jupiter's Satellites. 8vo.

———: Note on the resolution of $x^n + \frac{1}{x^n} - 2 \cos na$ into factors. 1868, 4to.

———: Values of the first 62 numbers of BERNOUILLI. 8vo.

ADCOCK (R. J.) Gravitation to the Sphere and the two ellipsoids of revolution. Cincinnati, 1872. 4to.

AIRY (G. B.): Appendix to the Greenwich Observations, 1837, containing Logarithms of Sines and Cosines to time: and Tables for converting sidereal time into mean solar time. London, 1838. 4to.

———: Catalogue of 1,439 stars for 1840.0.

———: Catalogue of 2,156 stars (12 year).

———: Catalogue of 1,576 stars (6 year).

———: Catalogue of 2,022 stars (7 year).

———: Catalogue of 2,760 stars (7 year).

———: Catalogue of 2,263 stars (9 year). 6 vols. London, 1843-1876. 4to.

———: On a new construction of the Divided Eye-glass Double-Image Micrometer. London (1845). 4to.

———: Description of the Great Equatorial at the Royal Observatory, Greenwich. London (1868). 4to.

———: On Sound and Atmospheric Vibrations, London, 1868. 12mo.

———: The transits of Venus, 1874 and 1882. London, 1868, 8vo.

———: History and Description of the Water Telescope of the Royal Observatory. London (1871). 4to.

AIRY (G. B.): British Transit of Venus Expeditions, 1874. Instructions to observers. Greenwich, (1874). 4to.

———: Inferences for the Value of the Solar Parallax, from [eye] observations of the Transit of Venus, 1874. London, 1877. 8vo.

———: Report on the Observations of the Transit of Venus, 1874. London, 1877. folio.

———: Account of Observations of the Transit of Venus (1874). London, 1881. 4to.

———: *See* ENCKE.

———: *See* Encyclopædia of Astronomy.

ALBANY: Dudley Observatory. Dudley Observatory and the Scientific Council. Albany, 1858. 8vo.

———: Dudley Observatory. A letter [anonymous] to the majority of the trustees. Albany ? 8vo.

———: Dudley Observatory. *Annals.* Vol. I (1866), II (1871). Albany. 8vo.

———: Dudley Observatory. *Report* 1863, 1878. Albany. 8vo.

ALBRECHT. (Th.): Formeln und Huelfstafeln. 2d edition. Leipzig. 1879. 8vo.

ALEXANDER (S): Expedition to Labrador to observe the Total Solar Eclipse, 1860. Washington, 1860. 4to.

———: Harmonies of the Solar System. Washington, 1875. 4to.

ALMANAQUE NAUTICO: Para el ano 1881, 1882. Madrid. 8vo.

ALVORD (B): The tangencies of circles and of spheres. Washington, 1855. 4to.

AMERICAN ALMANAC (The): 1835-6-7-8-9, 1840-1-2-3-4-5-6-7-8-9, 1850-1-2-3-4-5-7-8-9, 1860-1. Boston. 8vo.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: *Proceedings.* Vols. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 16, 29 (2 vols.) 30. 1848–1881. 8vo.

AMERICAN EPHEMERIS: and Nautical Almanac for the year — 1855-6-7-8-9, 1860-1-2-3-4-5-6-7-8-9, 1870-1-2-3-4-5-6-7-8-9, 1880-1-2-3-4-5-6. Washington. 8vo.

———: Tables to facilitate the reduction of places of the Fixed Stars, Washington, 1869. 8vo.

AMERICAN JOURNAL OF MATHEMATICS: Vol. III, Nos. 2-3, Baltimore, 1880. 4to.

AMERICAN JOURNAL OF SCIENCE: *First Series;* vols. 45, 46, 47, 48, 49, 50, (Index). *Second Series;* vols. 1, 2, 3, 4, 5, 6, –, 8, 9, 10, (Index), 11, 12, ———, 47, 48, 49, 50, (Index). *Third Series;* vols. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, (Index), 11, 12, 13, 14, 15, 16, 17, ——, 26; also, single Nos. 20, 21, 38, 39, 40, 41, 42, 43, 46, 47, 48, 55, 80, 94. New Haven, 1843–51; 1869–84. 8vo.

AMPÉRE (A. M.): Essai sur la philosophie des Sciences. Part I. Paris, 1838. 8vo.

ANALYST (The): Vol. VI. Des Moines, 1879. 8vo.

ANDERSON (F): Bestämning af Planeten *Undina's* Bahn. Lund, 1870. 4to.

———: *Same. Semele.* Lund, 1872. 4to.

ANDRÉ (Ch.): Recherches sur le Climat du Lyonnais. Lyons, 1880. 8vo.
ANDRÉ ET RAYET: L' Astronomie pratique et les observatoires en Europe et en Amerique. Vol. I, II, III, IV, V. Paris, 1874–1878. 12mo.
ANGUINO (A): Viaje á Europa en comision astronomica. Mexico, 1882. 8vo.
ANNALS OF MATHEMATICS: Edited by O. STONE and W. M. THORNTON. Volume I (current). Cincinnati, 1884. 8vo.
ARAGO (F.): Astronomie Populaire. Vols. 1, 2, 3, 4. Paris, 1854–1857. 8vo.
ARGELANDER (F.): Uranometria Nova. 1 vol. text, and atlas. Berlin, 1843. 16mo.
———: Hülfstafeln zur Berechnung der Beobachtungen in den südlichen Zonen. Bonn, 1852. 32mo.
———: *Atlas* Bonner Durchmusterung. Bonn, 1857. Folio.
———: De stella β Lyræ variabili. Commentatio altera. Bonn, 1859. 4to.
———: Nordlichter beobachtet in den Jahren 1823–1837. Helsingfors. 1866, 4to.
———: Eigenbewegungen von 250 Sternen. Bonn. 4to.
———: Fehlerverzeichniss für die BESSEL'SCHEN Zonenbeobachtungen $-2°$ bis $+45°$. Bonn. 4to.
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———: Verbesserungen zu verschiedenen Stern Verzeichnissen.
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Aus Band VII Bonner Beobachtungen. Bonn. 4to.
ARGELANDER: *See* KRUEGER.
ASTEN (E. von): Resultate aus O. v. STRUVE'S Beobachtungen der Uranus-Trabanten. St. Petersburg, 1872. 4to.
———: Untersuchungen über die Theorie des Encke'schen Cometen. Abhandlung I—II. St. Petersburg, 1873–1878. 4to.
ASTRAND, (J. J.) Ny interpolations methode. 1871. 8vo.
ASTRONOMICAL INSTRUMENTS: See Catalogues of.
ASTRONOMICAL JOURNAL: Vols. (1–2–3); 4; (5–6). 3 vols. Cambridge, 1851–1859. 4to.
ASTRONOMICAL REGISTER: General Index to the first twenty volumes, by F. W. LEVANDER. London, 1883. 8vo.
ASTRONOMISCHE NACHRICHTEN: Nos. 529 to 552. In *Astronomical Pamphlets.* Vol. 2. Altona. 4to.
———: Vols. (30–1), 43, 44, (45–6–7), (48–9–50), (51–2–3), (54–5–6), (57–8–9) (60–1–2). (63–4–5), (66–7–8), (69–70–1), (72–3–4), (75–6–7), (78–9–80), (81–2–3), (84–5–6), (87–8–9), (90–1–2), (93–4–5), (96–7–8), (99–100–Ergänzungsheft), 101, 102, 103, 104, 105; *also* (General-registers, vols. 1–80). Altona-Kiel, 1850. 4to.
ASTRONOMICAL NOTICES: Nos. 1–20. Ann Arbor, 1858. 8vo.
AUWERS (A.): Neue Reduction der BRADLEY'SCHEN Beobachtungen, 1750–1762. Zweiter Band. St. Petersburg, 1882. 4to.
BACHE (A. D.): Magnetic Survey of Pennsylvania. Washington. 4to.

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———: See BREWSTER.

———: See GOULD.

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BACKLUND (A. V.): Bestämning af Polhöjden för Lunds Observatorium. Lund. 4to.

BAILLAUD (B.): Sur une transformation employée par HANSEN. Paris, 1878. 8vo.

———: Sur la méthode de HANSEN, pour la détermination des perturbations absolues des petites planètes. Paris, 8vo.

BAILY (F): Astronomical Tables and Formulæ. London, 1827. 8vo.

———: *See* LACAILLE.

———: *See* LALANDE.

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———: Bestimmung der Constante der täglichen Nutation. Kiel, 1883. 4to.

BALL (R. S.): Elements of Astronomy. London, 1880. 8vo.

BARCLAY (J. G.): Astronomical Observations during the years 1865–69 (Vol II.) 1878 (Vol IV.) London, 1870. 4to.

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———: On the performance of fluid telescopes. London, 1831. 4to.

———: On the construction of a fluid lens refracting telescope. London, 1833. 4to.

———: *See* Encyclopædia of Astronomy.

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———: On an alleged error in LAPLACE'S Theory of the Tides 1877. 8vo.

———: On the Internal Structure of the Earth. Washington, 1877. 8vo.

BARTLETT, (A. K.): Studies in Astronomy. Battle Creek (no date). 12mo.

BAUERNFEIND (C. M.): Elemente der Vermessungs Kunde. Vols. I–II. Munich, 1856. 8vo.

BAUMHAUER (E. H.): Ueber einen Universal-Meteorographen. Leipzig. 8vo.

BEAUJEAN (A): *See* LITTRÉ.

BECKETT (E.): Clocks, Watches and Bells. London, 1874. 8vo.

BEEBE (W.): The Comet of 1771; its orbit. New Haven, 1879. 8vo.

———: Four place tables. New Haven, no date. 32mo.

BELL (A. G.): The multiple telegraph. Boston, 1876. 8vo.

BENSON (L. S.): Notes on the first book of BENSON'S Geometry, etc., etc. etc. New York, 1873. 8vo.

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BERGLAND (E.): See GYLDÉN.

BERLIN: Academy of Sciences. Akademische Sternkarten. 1 vol. Text, and atlas. Berlin, 1859. Folio.

———: K. Meteorologisches Institut. Ergebnisse der meteorologischen Beobachtungen in 1880–1–2. Berlin. 4to.

———: K. Preussiches Geodaetisches Institut. *Publicationen.* Astron. Geodätische Arbeiten, 1870, 1871, 1872–69–67, 1879–80, 1881–82. Leipzig and Berlin. 4to.

———: ———. Das Rheinische Dreiecksnetz. III Heft. Berlin, 1882. 4to.

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———: Observatory. *Bericht* für 1866, 1867, 1868–71. Berlin. 8vo.

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———: *Circulars*: Nos. 1—217, except 6, 12, 13, 14, 15, 16, 23, 102, 107, 152, 158, 161, 208, missing. Berlin. 8vo.

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———: Populäre Vorlesungen. Hamburg, 1848. 8vo.

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———: Recensionen. Leipzig, 1878, 8vo.

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BOBOULIEFF (D.): Dissipation of Electricity in Gases. Trans. by C. ABBE. New Haven, 1874. 8vo.

BODE (J. E.): Astronomisches Jahrbuch. 1784–5–6–7–8–9; 1790–1–2–3–4–5–6–7–8–9; 1800–1–2, also Supplement-Band I (1793), and II (1795). Berlin. 8vo.

BŒDDICKER (O.) Physical Appearance of Jupiter during 1880–1. Dublin, 1882. 4to.

———: Physical Appearance of Mars during 1881. Dublin, 1882. 4to.

BŒDDICKER (O.): On the influence of Magnetism on the Rate of a Chronometer. . Dublin, 1883. 4to.

———: *See* Lord ROSSE.

BŒRGEN (C.): *See* COPELAND.

BOGUSLAWSKI (P. H. L.): Auszug aus der Uebersicht der Arbeiten * * der Schlesischen Gesellschaft für vaterlaendische Kultur. *Vortraege*, 1840-1-2-4-5-6-7-8. *Anhang* [to the above] for 1843-46-47. [Meterological Observations]. Breslau. 4to.

———: On the use of a new Micrometer and its application to the determination of the parallax of Mars. London. 4to.

BOHLIN (K.) Bestämning af Upsala observatoriums Polhöjd. Stockholm, 1882. 8vo.

BOND (G. P.): The use of equivalent numbers in *** least squares. Cambridge, 1856. 4to.

———: On [STEINHEIL'S] new form of object-glass. Cambridge, 1863. 8vo.

———: On the relative brightness of the Sun and Moon; on the light of the Moon and *Jupiter;* In *Astronomical Pamphlets.* Vol. I.

———: *See* BOND (W. C.).

BOND (W. C.), GRAHAM (J. D.) and BOND (G. P.): Latitude of the Cambridge observatory. In *Astronomical Pamphlets.* Vol. 2.

BONN: Observatory. *Astronomische Beobachtungen.* Vols. 1, 2, 3, 4, 5, 6, 7. Bonn, 1846–1869. 4to.

[BONN]: [University of] Circular of the Bureau of Education. Washington, 1882. 8vo.

BOSS (L.): Declinations of Fixed Stars. Washington, (1877). 4to.

———: Observations of the Transit of *Mercury*, 1878. Albany, 1878. 8vo.

BOSTON: American Academy of Arts and Sciences. Centennial Volume. Volume XI, part I. Cambridge, 1882. 4to.

———: American Academy of Arts and Sciences. *Proceedings.* Vols. 1–2. (1846–1852). Boston. 8vo.

BOTHKAMP: Beobachtungen angestellt auf der Sternwarte, etc., herausgeben von H. C. VOGEL. Heft I (1872), II (1873): herausgegeben von O. LOHSE. Heft III (1875). Leipzig. 4to.

BREEN (H.): The moon's semidiameter from occultations. London, (1864). 4to.

———: Same, bound in Astronomical Pamphlets. Vol. 3.

———: Correction of BOUVARD'S elements of *Jupiter* and *Saturn.* London, (1868). 4to.

BREMIKER (C.): Logarithmorum VI decimalium Nova Tabula Berolinensis. Berlin, 1852. 8vo.

———: G. VON VEGA. Logarithmisch-trigonometrisches Handbuch. 40th edition. Berlin, 1856. 8vo.

———: Logarithmisch-trigonometrische Tafeln mit 5 Decimal-stellen. 3d edition. Berlin, 1880. 8vo.

———: (C.): Tafel vier stelliger Logarithmen. Berlin, 1874. 8vo.

BRESLAU: Observatory. Mittheilungen * * * über die hier bisher gewonnen Resultate für die geographischen und klimatologischen Ortsverhältnisse, etc. Breslau, 1879. 4to.

BREWSTER (D.): A treatise on optics. A new edition by A. D. BACHE. Philadelphia, 1841. 8vo.

———: The Martyrs of Science. Lives of GALILEO, TYCHO BRAHE and KEPLER. London, no date. 8vo.

BRISBANE (T. M.): Catalogue of 7385 Stars. London, 1835. 4to.

BRUENNOW (F.): Lehrbuch der Sphaerischen Astronomie. Berlin, 1851. 8vo.

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———; Tables of *Victoria*. New York, 1859. 4to.

BRUHNS (C): De planetis minoribus. Berlin, 1856. 4to.

———: J. F. ENCKE, Sein Leben und Wirken. Leipzig, 1869. 8vo.

———: Längen-differenz; Berlin-Lund. Lund, 1870. 4to.

———: Die Declinationen der bei der Gradmessung benutzten Fixsterne. 1871. 4to.

———: Mittheilung ueber die Ermittelung der Coördinaten der Pleissenburg, etc. Leipzig, 1872. 8vo.

———: Atlas der Astronomie. Leipzig, 1872. Oblong, 4to.

———: Ueber die von Herrn L. R. SCHULTZE abgeleiteten Elemente des Cometen I, 1830. Leipzig, 1872. 8vo.

———: Die Astronomen auf der Pleissenburg. Leipzig, 1878. 4to.

———: A new manual of logarithms. 2 edition. Leipzig, 1881. 8vo.

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———: SEE LEIPZIG.

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BUCKINGHAM (C. P.): The method of * * * limits. Chicago, 1879. 8vo.

BURNHAM (S. W.): New Double Stars. London, 1878. 8vo.

———: Report to the Trustees * * * of Observations made on Mt. Hamilton. Chicago, 1880. 4vo.

———: A new method of illumination for position micrometers. London, 1882. 8vo.

———: Catalogue of 81 Double Stars [new]. London. 8vo.

———: Double Star observations made 1874–8 Chicago; *same* 1879–80. Bound in 1 *vol.* London. 4vo.

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BURTON (C. E.) and GRUBB (H.): On a new form of Ghost-micrometer. Dublin, 1880. 8vo.

CAMBRIDGE: Annals of the Astronomical Observatory of Harvard College. Vol 1 (2v), 2 (2v), 3, 4, 5. 6, 7, 8, 6, 10, 11, 12, 13 (i). Cambridge, 1856–1882. 4to.

CAMBRIDGE: Harvard College Observatory. *Report of the Director* for 1864; 1877–78–79; 1880–81–82–83, Cambridge. 8vo.

CAMBRIDGE (Eng.): Observatory. *Astronomical Observations.* Vols. 2, 3, 4, 5. Cambridge, 1829.

CANADA: Reports on the Meteorological, Magnetic and other Observatories of Canada. [Blue-book.] Ottawa, 1875. 8vo.

CAPE OF GOOD HOPE: Royal Observatory Astronomical Observations in the year 1834. Cape of Good Hope, 1840. 4to.

———: Royal Observatory. Results of Astronomical Observations xxx in the years 1856–7–9. 1871–3 (1v) 1874–5–6. Cape Town, 1871–1876. 8vo.

———: Royal Observatory. Catalogue of 87 Circumpolar Stars. Cape Town, 1882. 8vo.

CARL (P.): Die Principien der astronomischen Instrumenten Kunde. Leipzig, 1863. 8vo.

———: Repertorium der Cometen-Astronomie. Munich, 1864. 8vo.

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	h.	m.	h.	m.	°	′	°	′
No. 1	0	0	to 0	12;	+ 6	0	to + 9	30.
3	8	53	to 9	9;	+28	15	to +30	0.
4, 5	9	31	to 9	41;	+17	30	to +20	15.
6	12	27	to 12	41:	— 1	0	to — 4	0.
7, 8, 9, 10	15	12	to 15	21;	—12	30	to —23	15.
11, 12	16	4	to 16	38;	+14	15	to +17	15.
13	16	20	to 16	34;	—24	0	to —23	0.
14	20	58	to 21	10;	—25	15	to —26	0.
15	22	38	to 22	48;	— 2	45	to + 1	0.
16, 17	23	0	to 23	10;	— 2	45	to + 4	15.
18	23	10	to 23	20;	— 8	0	to —11	30.
19	23	48	to 24	0;	+ 6	0	to + 9	30.

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